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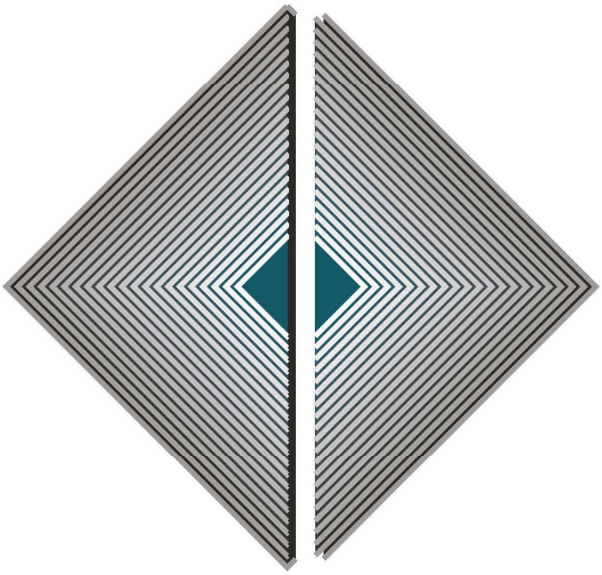

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ENVIRONMENTAL EDUCATION IN PRESCHOOL AGE AS AN EDUCATIONAL PRIORITY

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Preschool age is one of the most sensitive and important periods for the formation of a person's relationship with the world. It is then that a child first begins not only to get to know the environment, but also to understand his place in it. Therefore, environmental education at this stage cannot be perceived as a narrow topic about waste sorting or individual cleaning campaigns. Preschool environmental education is extremely important because a positive attitude towards nature is formed in childhood. Young children more easily acquire values and habits, therefore the development of ecological awareness already in preschool age makes sense. Children who learn to care for the environment (e.g., through waste disposal, water or energy conservation) will carry these habits into adulthood, reducing potential environmental damage in the future. Early Childhood Environmental Education (ECEE) is increasingly being included in preschool programs, emphasizing its important role in raising environmentally conscious and sustainably behaving generations from an early age (Lepičnik Vodopivec & Šindić, 2025). Thus, environmental education at an early age not only helps to develop environmental awareness but also promotes skills and attitudes that can determine a sustainable and responsible lifestyle in the future (Lamanauskas, 2023).

Environmental education at this stage of education is the beginning of forming a responsible relationship with nature, life, resources, and man himself. This primarily means not only introducing children to nature, ecology, or a sustainable lifestyle, but also responsible behavior through various daily activities, observation, play, and personal experience. It is also important to understand that early environmental education is not only the transfer of knowledge, but also the development of values. During early childhood education, a person's attitude towards nature is formed, which is related to the internalization of values (Aramavičiūtė, 2002). Children learn not only to recognize plants or understand why it is necessary to save water. They learn to feel a connection to nature, develop responsibility, empathy, awareness, and realize that human actions have consequences. And those consequences can be various, and most often negative. Teacher practitioners note that it is important not only to convey knowledge about nature/environment, but also to create conditions for children to explore, experiment, and observe the processes taking place in the environment themselves (Lavickienė, 2026). Even more significant is to form children's understanding that caring for the environment is not an imposed rule, but a natural part of a responsible life. The activities already mentioned undoubtedly help to form sustainable habits, ecological awareness, a sense of responsibility, and even critical thinking. It is precisely the activities of the environmental context that not only promote the formation of children's ecological worldview but also help consolidate values related to the protection of nature and responsible behavior (Sawitri, 2017).

Another equally important aspect is the realization that a child does not learn about environmental protection from theoretical definitions, explanations, and concepts. Children learn through practical activities. Researchers have found that children learn about environmental protection more effectively through practical activities (Hansen & Sandberg,

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2020). Particularly outstanding are play-based and inquiry-based learning strategies that involve simple experiments and model building, which allow children to better understand complex environmental aspects, such as energy consumption and water conservation, in a practical way. Such activities encourage children to engage and reflect on their daily sustainability habits, making learning more accessible and interesting (Geduld & Majola, 2025; Souza et al., 2025). Again, practicing teachers note that environmental education should respond to children's natural curiosity, involve them in active exploration of the environment, encouraging a deeper understanding of environmental objects, phenomena, and their interrelationships, and discover various ways of knowing and learning (Navickienė & Obrikienė, 2026). Children should not only hear about nature, but also observe, touch, grow, explore, and protect it. Only then does education become alive, inclusive, and long-lasting. A child who plants a plant, sorts waste, or conducts research in nature understands the meaning of environmental protection much more deeply than one who is only told about it.

The third aspect that is worth emphasizing is episodicity. Environmental education can be effective and efficient when it is not only episodic (episodic activity). First of all, because children's awareness and behavior change not after one topic or one organized event, but when environmental principles are consistently integrated into everyday life. This forms adequate and meaningful habits, for example, turning off the tap, collecting garbage, sorting waste, using resources more economically, etc. A culture of habits is gradually formed.

The fourth aspect is no less meaningful. A preschool institution is not able to independently provide comprehensive education in the field of environmental protection. First of all, because a child learns by observing the behavior of adults, therefore, the example of parents, the habits of the home environment, and the general attitude towards nature have a significant influence. Various studies confirm that children learn by observing and imitating adult behavior (Deguchi et al., 1988; Hardecker & Tomasello, 2017; Paulauskaitė et al., 2026). Often, fundamental contradictions arise here between what the preschool institution declares and how the aforementioned principles operate at home. Thus, environmental education will not be effective if it is not a joint agreement between the kindergarten and the family.

The fifth aspect, the difficulties/limitations in organizing and implementing the environmental education process on the one hand, and the competencies of preschool teachers, on the other. It is obvious that not everything depends solely on the teacher's desire/efforts or family awareness. Very specific structural obstacles often exist. These may include a lack of resources, limited access to suitable educational spaces, restrictions in the urban environment, lack of funds for field trips, a large number of children in groups, lack of time, as well as the need for methodological assistance and professional development. Another problematic area related to this is the training (preparation) of preservice preschool teachers for environmental education. One of the latest studies has shown that although preservice teachers are aware of the importance of environmental education at an early age, their professional preparation in this area is not yet sufficiently consistent and systematic (Lamanauskas & Malinauskienė, 2025). This suggests that teacher training programmes need a more focused integration of environmental education, greater attention to experiential learning, practical methods, and analysis of real educational situations. It is recommended that teacher training programs be improved by incorporating innovative teaching methodologies and activities to strengthen students' environmental literacy (Dolenc Orbanić & Kovač, 2021). For example, studies show that after an environmental education course, the pro-environmental behaviour of preservice teachers improved, which indicates that not only words are important, but also the authentic learning process and the example that teachers themselves demonstrate (Bibi et al., 2026).

So, environmental education should not turn into just a declarative pose. After all, we often talk to children about sustainability, but we often act the opposite ourselves. Or we excessively admire the use of "secondary raw materials", while the quality of the educational activity itself

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suffers significantly. We should not forget that children sensitively record not only what we say, but also how we behave. True environmental education begins not with catchy slogans, but with a consistent, authentic example. If an educational institution lives by its declared values, children naturally accept them. Research also reveals that teachers who themselves understand and value the importance of environmental education can more effectively transmit these values to students. Teachers' attitudes and involvement in environmental education are essential factors in promoting children's environmental awareness and responsibility. This shows that education should not only be theoretical but also grounded in real-world examples and practical activities that encourage students to engage and develop empathy for nature (Imran & Almusharraf, 2024; Yeşilyurt et al., 2020).

Today's environmental education is much broader than just the usual knowledge of nature. It is not only about knowing plants, animals, or observing the seasons, etc. It is also about sustainable consumption, not wasting food, saving water and electricity, reducing air pollution, developing renewable energy sources, and finally, community spirit and even a healthy lifestyle. Environmental education in preschool age becomes (must become) a holistic approach to life. The child learns not only about nature but also about being responsible in the world. Environmental education in preschool should be understood as a holistic approach to life, encompassing not only environmental knowledge but also social, economic, and ecological aspects. Research shows that preschool teachers often initially understand sustainability only from an environmental perspective, but as they become involved in educational projects, they begin to integrate the dimensions of social sustainability, linking local challenges with global ones (Borg & Gericke, 2021).

Therefore, today it is worth talking not about whether environmental education is necessary at the preschool stage. It is much more important to ask whether we are giving it enough attention, quality conditions, and real non-declarative educational content. If we want the person of the future to be responsible for the environment, we must start from the very beginning - from kindergarten, from a daily example, from small but consistent actions that become the basis for a child's perception of the world. This leads to the need for deeper and more detailed research on this issue. Such research in the field of environmental education in preschool should primarily be directed at assessing the long-term effectiveness of experiential and inquiry-based learning, in order to determine which specific practical activities are most likely to form sustainable habits and promote value internalization. Also critically important are studies that analyze the mechanisms of family-kindergarten interaction/cooperation and educational interventions that reduce contradictions between declared values and everyday behaviour, since children learn primarily by imitating adults. In addition, systematic studies of future preschool teacher training programmes are needed, revealing gaps in competencies and modeling ways to integrate environmental education into professional training not episodically, but consistently and systematically.

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A FRAMEWORK ON TEACHING COMPETENCE OF ALTERNATIVE LEARNING SYSTEM MATHEMATICS TEACHERS

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Abstract

There is limited research on the teaching competence of mathematics teachers in the Philippines Alternative Learning System (ALS). This study examined how the individual, institutional, and contextual factors influence the teaching competence of ALS mathematics teachers. A survey research with a quantitative, descriptive-correlational research design was used, involving 114 ALS mathematics teachers from the six (6) school divisions of the Department of Education (DepEd) in Region XI, Southern Philippines, selected through stratified random sampling. Guided by Bronfenbrenner's Bioecological Theory and Bandura's Self-Efficacy Theory, the study utilized multilevel analysis to account for the hierarchical structure of the data. Results of the multilevel analyses showed that mathematics teaching efficacy, mentorship, collaborative teaching, and community linkages significantly predicted teaching competence. The findings shed light on the key factors that shape teaching competence in ALS, linking teaching competence to a combination of individual teaching skills and institutional support. This study provides policymakers, program managers, and educational leaders with evidence-based information to support quality mentoring and collaborative teaching and to design context-responsive educational support. The findings have potential application in designing high-quality professional development activities to improve teaching competence in non-formal education environments.
Keywords: *alternative learning system, educational support, mathematics teachers, teaching competence, multilevel analysis*

Introduction

Education is a key element in the lives of individuals and nations, particularly in areas without access to formal education. It is an essential instrument for reaching the poor, as such, realizing equity, progress, and inclusive development. It can enable those less privileged to improve their social mobility, boost their productivity, and help their countries toward growth (Enchikova et al., 2024; Tariq et al., 2025; Vicente et al., 2021; Yildiz, 2023; Zamir et al., 2023; Zhang & Fan, 2024).

Despite national and even global efforts to break educational barriers, many out-of-school youth and adult learners (OSYAL) in the Philippines still lack full access to formal schooling. This is due to a combination of socio-economic and structural challenges, including poverty, remoteness, work commitments, and family responsibilities. In addition, this scenario, with the aforementioned factors present, makes it even more challenging for learners to access and complete basic education in formal school systems, thereby perpetuating educational inequalities (Anlimachie & Avoada, 2020; Sibusiso et al., 2025; Silva-Laya et al., 2020).

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In response to worldwide calls for inclusive education, the Philippine government, through the Department of Education (DepEd), opened learning opportunities for OSYAL through the ALS, which introduced them to learning programs. ALS is a parallel but independent learning program for the learners that utilizes non-formal learning approaches to cater to their educational needs through learning programs situated within their community (Cagang, 2024; Mahinay & Manla, 2025; Republic Act No. 11510, 2020; Valenzuela, 2010). The ALS aims to address educational exclusion through learner-centered programs that accommodate diverse learning needs and life circumstances (Estrada et al., 2019).

Despite the expansion of access to education for youth from non-formal education settings into OSYAL, sustaining high-quality learning outcomes remains a significant challenge. In addition to access to formal education, institutional quality is more important for high-quality learning outcomes, particularly in parallel learning environments where students have diverse formal and non-formal educational experiences before enrolling in the program. The bottom line is that the quality of learning outcomes ultimately depends on teachers' qualifications and competencies. Teachers are responsible for delivering the curriculum to learners in a learning-focused environment. As style can affect learning, teachers must adjust to the needs of individual learners.

Mathematics teachers teaching learners with different knowledge gaps and constraints in a class with diverse backgrounds and capabilities have always been a challenge. While delivering mathematics education can enhance problem-solving skills, critical thinking, and full participation and contribution to the socio-economy and society for all individuals, it remains a priority area of research and teaching practice. (Chaiarwut et al., 2025; Komarudin et al., 2024). A teacher may have sufficient content knowledge to teach mathematics in a traditional school setting, but they must know more than that to work in an ALS program. Instead, teachers need to induce various teaching methods, assess students' learning, and differentiate their teaching according to the learning needs of their students (Feng et al., 2023; Saoke et al.).

The teaching competence of ALS mathematics teachers is one of the factors that affect teaching quality. In today's classrooms, teaching competence is not only measured by a teacher's content knowledge or subject-matter competence, but also by their ability to manage the classroom and deliver instruction that meets the learning needs of diverse learners. Teaching competence, therefore, is critical in mixed-ability classrooms where the teacher has to decide on lessons suitable for struggling learners on the one hand and for learners who are already advanced for their age on the other. This involves thoroughly assessing students' knowledge and skills. Research shows that teaching competence is influenced not only by a teacher's traits and characteristics but also by institutional and contextual attributes inherent in education (Velasco & Lomibao, 2024; Villastique & Ubayubay, 2025; Yang & Kaiser, 2022). The institutional context may provide mentoring, collaborative spaces for professional learning, policy support, and resources that facilitate effective teaching.

Although earlier studies have explored teaching competence, they are mostly one-dimensional analyses that only highlight individual teacher factors or organizational characteristics (Darling-Hammond et al., 2019; Berg et al., 2025). Unfortunately, this gap is more apparent in the ALS context, in which the implementation of an individual teacher's teaching practice takes place within a series of interconnected systems that take into account not only their capabilities but also educational structures and conditions within schools and communities. Isolation would dismiss the overarching and synergetic role of these factors in efficacy as a teacher. Therefore, a multilevel approach is needed to capture in more detail how these layers are related to teaching competence.

Thus, this study aimed to examine the teaching competence of ALS mathematics teachers in Region XI by analyzing the influence of individual, institutional, and contextual factors using a multilevel analytical approach. Specifically, the study seeks to provide empirical

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evidence on how each of these interrelated factors contributes to teaching capacity and to create a framework that can aid policy-making, institutional strengthening, and targeted professional development for ALS mathematics teachers.

Research Problem

The ALS is one of the key interventions to respond to the learning needs of OSYAL in the Philippines. Amid reforms across the country to address the learning needs of these learners, the DepEd has also strengthened the ALS policy and programmatic frameworks. While participation in ALS has increased in recent years, the focus remains on improving the quality of mathematics instruction, particularly to identify gaps in addressing the learning needs of ALS learners.

Teaching competence is a key determinant of the quality of education and learning outcomes, particularly in ALS settings (Letzel et al., 2022). Teaching Mathematics in this setting poses unique challenges, as ALS learners can vary widely in their academic backgrounds, learning gaps, and life situations. Teaching competence does not just require content knowledge, but also pedagogical flexibility, differential instruction and assessment techniques, and inclusive and adaptive approaches. However, there remains a lack of empirical data on the teaching competence of ALS mathematics teachers, despite these competencies being significant.

Moreover, prior research generally examines teaching competence on a single level of analysis, focusing primarily on individual teacher characteristics (Kurschning et al., 2025; Molina-Moreno et al., 2024; ten Hagen et al., 2022). However, such lenses fail to account for the complex and multi-dimensional vectors of educational contexts in which teaching practices are situated at different levels of analysis (individual characteristics, institutional settings, regional ecosystems). These few multilevel tests of such models limit a more complete understanding of how these factors relate to one another in influencing teaching competence. Therefore, a multilevel exploratory study is needed to investigate the teaching capabilities of ALS mathematics teachers in relation to context effects that function at multiple levels of the education system.

Research Focus

This study explored the teacher's mathematics teaching competence as a means to improve institutional quality in the ALS. In the parallel learning system set up as a non-formal educational system for the OSYAL, teaching competence is not confined to simple aspects. However, it encompasses broader dimensions to address learners' diverse needs for effective, meaningful, and appropriate teaching of mathematics.

More specifically, this study explored teaching competence as evidenced by key instructional dimensions required for ALS mathematics instruction. These involve pedagogical and content knowledge, learning environment management, differentiated instruction principles, assessment, and feedback (Ansari, 2020; Chávez-Ventura, 2025; Kalim, 2024). These dimensions captured the unique nature of teaching demands for ALS mathematics teachers who address a diversity of learner profiles, academic backgrounds, and contextual challenges that are typical of non-formal learning environments in accordance with Goodman's (1994) nested structure of educational systems (Yang & Kaiser, 2022).

The study explored in greater detail the different levels at which factors affecting teaching competence operate. Teacher characteristics and professional attributes were assessed at the individual level, as they can impact teaching competence. Conditions of schools and programs that are conducive to or limit effective teaching practices at the institutional level were analyzed. Regional context considerations included policy support, training opportunities, and resource allocation within the DepEd.

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Using a multilevel approach, this study explored how individual, institutional, and regional factors interact with the teaching competency of ALS mathematics teachers. This influx of data, when linked to socio-political environments, also allowed for a move away from single-level explanations and provided greater insight into teaching competence in the ALS. These results provide empirical evidence to guide policy decisions, professional development programs, and targeted interventions on the program level.

Research Aim and Research Questions

This study on the teaching competence of ALS mathematics teachers sought to explore how individual, institutional, and regional factors explain variations in ALS teachers' teaching competence. The study's findings can explain variations in teaching competence within the ALS program and inform DepEd policymakers and program managers on issues and interventions to improve teaching competence for OSYAL. From a multilevel perspective, the findings also provide a basis for understanding how teaching competence can be improved through a combination of individual and contextual factors.

To achieve this aim, the study addressed the following research questions:

1. What is the level of teaching competence of ALS mathematics teachers in terms of:
   a) Pedagogical and content mastery,
   b) Learning environment management,
   c) Differentiated mathematics instruction, and
   d) Assessment and feedback practices?
2. What individual-level factors are associated with the teaching competence of ALS mathematics teachers?
3. What institutional-level factors are associated with the teaching competence of ALS mathematics teachers?
4. What regional-level factors are associated with the teaching competence of ALS mathematics teachers?
5. To what extent do individual, institutional, and regional factors predict the teaching competence of ALS mathematics teachers when analyzed using a multilevel framework?

Research Methodology

General Background

A quantitative, descriptive–correlational design with a multilevel analytical approach was used in this study to examine the teaching competence of ALS mathematics teachers. This study used a quantitative, descriptive–correlational design with a multilevel analytical framework to investigate the teaching competencies of ALS mathematics teachers in the Philippines. This study was conducted in Region XI (Davao Region), Philippines, for the school year 2024–2025. It was used for a quantitative design, which would be appropriate as it allowed the researcher to systematically measure and statistically analyze relationships amongst variables (Creswell, 2014; Kerlinger & Lee, 2000). A descriptive–correlational design was used to describe the level of teaching competence and identify its association with individual, institutional, and regional levels. This design would be appropriate for investigating relationships in a non-manipulative educational context (Mohajan, 2020; Pamon & Oco, 2024).

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Given that educational systems have a nested structure, multilevel analyses were conducted because the dataset was hierarchical. Multilevel analysis has been widely used to examine influences across levels and to control for interdependencies in clustered data (Hox et al., 2018; Raudenbush & Bryk, 2002). By doing so, the study was able to acquire and consolidate these determinants whilst segregating them into individual-level, institutional-level, and regional-level factors related to teaching competence.

Sample

A stratified random sampling method was used to ensure that ALS math teachers from urban, semi-urban and rural schools representing Region XI or also called as Davao Region in the Southern Philippines are proportionately represented in the survey. The respondents were selected from six School Division Offices (SDOs) to allow for variation in educational contexts across the region. The sample was diverse and representative, so as to capture variability across these educational institutions (Creswell, 2014).

To establish an appropriate sample size, an a priori power analysis was conducted using G*Power version 3.1.9.4 (Erdfelder et al., 1996). Using a medium effect size (r = .30), a significance level (α = .05), and a statistical power of .80, the minimum required sample size for correlation analyses was established as 67 participants (Faul et al., 2007). A total of 114 respondents were included in the study to support the analysis of multiple predictors. It is also noteworthy that the specified effect size of r =.30 is suitable for correlation-based assessments but does not precisely correlate with effect size conditions for multilevel regression models. With a small quantity of higher-level units in this research, its statistical power for detecting effects on the contextual level may be low as well. Thus, while the sample appears appropriate for single-level analyses, it is underpowered for multilevel modeling and accurate estimation of higher-level effects. Therefore, this limitation is taken into consideration while interpreting the results, particularly regarding some predictors being non-significant.

While multilevel analysis was utilized to account for the nested structure of them, the study is limited to a single region (Region XI), which serves as one macro-level unit. As such, the number of higher-level clusters remains limited, which may reduce statistical power at the contextual level and partly explain the non-significant findings for some regional-level predictors. These limitations are considered in the interpretation of the results. The sample size and educational settings in which the research was conducted provide a reasonable basis for contextual insights within Region XI.

Ethical standards were adhered to during the conduct of this research. Before collecting data from various locations where teachers were based, formal approval was obtained from the administrators at each location. Teachers were informed of the purpose of the research, presented with an informed consent form, and given the option to participate or withdraw from the research at any time without penalty. Confidentiality and anonymity were maintained by not collecting any personal and identifiable information from the teachers; all data was presented in an aggregate form. The data were collected for this research study only and used in compliance with the highest ethical standards for educational research.

Instruments and Procedures

The data from the respondents was collected using a structured survey questionnaire and composed of 65 items, with each construct comprising five items. Each response was assessed using a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), which is considered the most widely used way to measure perceptions and self-reported competencies in educational research (Barua, 2013). The questionnaire measured the independent variables,

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such as individual, institutional, and regional factors, and the dependent variable, teaching competence of ALS mathematics teachers. The individual level included instructional adaptability, mathematics efficacy, and professional development. The institutional level includes community linkages, curriculum implementation, mentorship, and collaborative teaching. Capacity building and training programs, policy implementation and support, as well as funding and resource allocation, were done at the regional level. Teaching competence was assessed in terms of pedagogical and content mastery, learning environment management, differentiated mathematics teaching, and assessment and feedback practices.

The constructs used were adapted and modified with respect to both theory and contextual consideration, particularly from Parto and Yango (2023), as well as the Mathematics Teaching Self-Efficacy (MTSE) scale, developed by Zuya et al. (2016). Other constructs not thoroughly addressed with current tools were obtained with a researcher-developed questionnaire based on literature, ALS curriculum guidelines, and contextual pedagogical methods. The instrument was validated by experts and pilot tested prior to data collection. The instrument was reviewed by experts in ALS education and by language and behavioral specialists for content validity, clarity, and appropriateness.

Internal consistency reliability was assessed by means of Cronbach's alpha (α) for each construct, all exceeding the acceptable level of. Methods were scored as having strong reliability, with $\alpha > .70$ (Naidoo et al., 2021; Farrés-Tarafa et al., 2021; Manor-Binyamini & Schreiber-Divon, 2020). Kaiser–Meyer–Olkin (KMO) values varied from .833 to .890, indicating at least adequate (Kaiser, 1974) sampling adequacy. Bartlett's Test of Sphericity was statistically significant ($p < .001$), which suggested the data were suitable for factor analysis (Bartlett, 1954). Factor loadings of convergent validity were supported ranging from 578 to .909, with values above .50; these are considered acceptable. Those above .70 indicate strong item-factor relationships (Hair et al., 2010; Tabachnick & Fidell, 2013). These findings affirm good reliability and construct validity of the instrument.

Table 1 below presents the results of the reliability and construct validity of the teaching competence, individual-level, institutional-level, and regional-level variables. All constructs had Cronbach's alpha coefficients between .91 and .97, and the subscale values ranged from .81 to .95, all above the recommended threshold of .70; these reveal strong to excellent internal consistency. Namely, teaching competence ($\alpha = .97$), individual level ($\alpha = .91$), ά, institutional level ($\alpha = .94$), and regional level ($\alpha = .93$) indicate a high level of reliability, meaning that the items are consistently measuring their intended constructs.

The Kaiser–Meyer–Olkin (KMO) ranged from .833 to .890, which indicates good sampling adequacy and confirms that the data are suitable for factor analysis (Kaiser, 1974). In addition, Bartlett's test of sphericity was statistically significant ($p < .001$) for all constructs, indicating that the correlation matrices were not an identity matrix and that sufficient inter-item correlations existed to justify factor extraction (Bartlett, 1954).

For construct validity, the factor loadings ranged from .578 to .909, above the permissible rate of .50, and a number of the items exhibited high loadings above .70. These results suggest adequate to strong item–factor relationships, support convergent validity, and confirm that the items reflect their intended constructs. In summary, it is clear from these findings that the instrument has robust psychometric properties and adequate construct validity, making it ready for further multilevel analyses.

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Table 1
Structure of the Research Instrument: Teaching Competence, Individual Level, Institutional Level, and Regional Level

Items Saturated by Factors	Factors	KMO	BTS (*p*-value)	Factor Loadings
Teaching Competence	.97	.890	< .001	
a. Pedagogical and Content Mastery	.89			.667-.751
b. Learning Environment Management	.93			.624-.881
c. Differentiated Mathematics Instruction	.94			.648-.891
d. Assessment and Feedback Strategies	.95			.779-.890
Individual Level	.91	.856	< .001	
a. Instructional Adaptability	.87			.742-.805
b. Mathematics Efficacy	.86			.717-.816
c. Professional Development	.81			.590-.798
Institutional Level	.94	.841	< .001	
a. Community Linkages	.85			.599-.844
b. Curriculum Implementation	.91			.638-.772
c. Mentorship and Collaborative Teaching	.91			.611-.793
Regional Level	.93	.833	< .001	
a. Capacity Building and Training Programs	.94			.703-.909
b. Policy Implementation and Support	.90			.589-861
c. Funding and Resource Allocation	.91			.578-.857

Procedures

A systematic and ethically grounded data-collection procedure was implemented among ALS mathematics teachers in Region XI, Philippines. This study was approved by the Research Ethics Committee (REC) of Bukidnon State University and followed ethical standards. After securing approval, relevant institutional permissions were subsequently secured, including approvals from the PUP Institutional Review Board as well as the DepEd Regional XI Office. ALS mathematics teachers were selected according to the sampling design of this study, a range covering teaching experience and the role in the ALS program, geographical representation through the six SDO in Region XI, and eligible respondents were then invited to participate in the data collection.

Informed consent of participants had been obtained before the actual conduct of the activity, which encompassed an explanation of the purpose of the study, the process and/or methodology to be conducted, terms and conditions of confidentiality, and voluntary participation in the research. Questionnaires distributed to participants were assigned unique codes to ensure the privacy and confidentiality of responses. The questionnaires were facilitated by the ALS focal persons based in the respective SDOs. All collected data were kept strictly confidential. Physical copies of the data were stored in a locked cabinet at the researcher's office, while the digital copies were securely uploaded to an online storage service. The online data storage was accessible to the researchers using a password-protected account. The analyzed data would then be tabulated and statistically analyzed in line with the research's goals and objectives.

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Data Analysis

The data were analyzed for this study using both descriptive and inferential statistics. To answer RQ1, descriptive statistics such as the mean were computed for the four domains of teaching competence. For RQ2, RQ3, and RQ4, Pearson's product–moment correlation (r) was used to examine the association between teaching competence and individual, institutional, and regional levels. To answer RQ5, multilevel regression analyses were conducted using hierarchical linear modeling (HLM), with data grouped by institutions within regions, given the study's nested design.

Research Results

The level of Teaching Competence of ALS Teachers

The level of teaching competence of ALS mathematics teachers based on triangulated self-rating, peer-rating, and head-rating is given in Table 2. By utilizing multiple evaluative perspectives, the strength of the results lies in capturing teachers' self-assessments, peers' and supervisors' observations regarding teaching competence and program implementation. Combining these perspectives allows for a more holistic evaluation of teacher effectiveness and mitigates any biases that may come from relying on just one source of evaluation.

Table 2
The Level of Teaching Competence of ALS Mathematics Teachers

Teaching Competence Indicators	*M*	Qualitative Description
Learning Environment Management	4.71	Very High
Assessment and Feedback Strategies	4.65	Very High
Differentiated Mathematics Instruction	4.59	Very High
Pedagogical and Content Mastery	4.56	Very High
General Mean	4.63	Very High

Table 2 presents the teaching competence indicators for ALS mathematics teachers across four key areas. The general mean is 4.63, which is described as Very High, indicating that teachers consistently demonstrated high levels of competence across learning environment management, assessment and feedback strategies, differentiated mathematics instruction, and pedagogical and content mastery. The four indicators are described as Very High. Specifically, learning environment management has the highest mean of 4.71, indicating that ALS mathematics teachers are good at establishing a systematic, caring, and orderly climate of learning conducive to non-traditional instruction. Followed by assessment and feedback strategies with a mean of 4.65, differentiated mathematics instruction with a mean of 4.59, and pedagogical and content mastery got the lowest mean of 4.57.

The results imply consistent quality in the teaching of ALS mathematics by ALS mathematics teachers. This finding indicates that teachers were prepared to manage the pedagogical, instructional, and assessment requirements of alternative learning structures. Considering the flexible, modular, and community-based characteristics of ALS, the general high level of competence among its teachers seemed to have enabled them to optimize teaching, manage learning settings, differentiate pedagogical approaches, and use assessment and feedback strategies that promote effective mathematics teaching across local conditions.

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Table 3
The Association Between Individual-Level Factors and the Teaching Competence of ALS Mathematics Teachers

Indicators	*r* -value	*p* -value	Decision	Remarks
A. Individual Level				
Instructional Adaptability	.208	.027	Reject	Significant
Mathematics Efficacy	.294	.001	Reject	Significant
Professional Development	.174	.064	Fail to Reject	Not Significant

Table 3 revealed the bivariate associations between teaching competence and individual-level indicators; specifically, instructional adaptability (r = .208, p < .027) and mathematics efficacy (r = .294, p < .001) were significantly associated with teaching competence at the bivariate level. In contrast, professional development (r = .174, p = .064) is not significantly associated with teaching competence. This indicated that ALS mathematics teachers' self-reported teaching competence was positively correlated with instructional adaptability and mathematics teaching efficacy. Yet the professional development, as measured in this study, was not statistically significantly associated with any measures at the bivariate level.

Table 4
The Association Between Institutional-Level Factors and the Teaching Competence of ALS Mathematics Teachers

Indicators	*r* -value	*p* -value	Decision	Remarks
B. Institutional Level				
Community Linkages	.062	.516	Fail to Reject	Not Significant
Curriculum Implementation	.357	<.002	Reject	Significant
Mentorship and Collaborative Teaching	.311	<.005	Reject	Significant

Bivariate correlations between predictors at the institution-level and teaching competence are presented in Table 4. Curriculum implementation (r = .350, p < .001) and mentor and collaborative teaching (r = .311, p < .001) are significantly correlated with teaching competence at the bivariate level. These findings indicate a positive relationship between instructional and professional support practices within institutions and reported teaching competence among ALS mathematics teachers. In contrast, community linkages (r = .062, p = .516) are not significantly associated with teaching competence. This suggests that the extent of reported community engagement did not demonstrate a measurable relationship between teaching competence at the bivariate level.

Table 5
The Association Between Regional-Level Factors and the Teaching Competence of ALS Mathematics Teachers

Indicators	*r* -value	*p* -value	Decision	Remarks
C. Regional Level indicators				
Capacity Building and Training Programs	.248	.008	Reject	Significant
Policy Implementation and Support	.229	.014	Reject	Significant
Funding and Resource Allocation	.241	.010	Reject	Significant

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Table 5 presents the bivariate association between teaching competence and regional-level indicators. Capacity-building and training programs ($r = .248$, $p < .008$), implementation and support of policies ($r = .229$, $p < .014$), and funding and resource allocation ($r = .241$, $p < .010$) show significant bivariate associations with teaching competence. The results show positive associations at the regional level with regard to support mechanisms and reported teaching competence of ALS mathematics teachers. Results show that the differences in training opportunities, policy support, and allocation of resources are statistically related to perceived competence for teaching within the ALS context.

Table 6

Multilevel Predictors of Teaching Competence across Individual, Institutional, and Regional level of the ALS Mathematics Teacher

Predictor	Estimate	Confidence Interval 95%	p-value	Interpretation
(Intercept)	4.89	4.65 – 5.13	<.001	Significant
Individual Instructional Adaptability (IA)	.051	-.099 – .201	.502	Not Significant
Mathematics Efficacy (ME)	.242	.033 – .451	.024	Significant
Professional Development (PD)	.072	-.132–.276	.487	Not Significant
Community Linkages (CL)	-.378	-.672 – -.084	.012	Significant
Curriculum Implementation (CI)	.095	-.147 – .337	.439	Not Significant
Mentorship & Collaboration (MC)	.349	.047 – .651	.023	Significant
Regional Training Programs (RT)	.052	-.156 – .260	.621	Not Significant
Regional Policy Support (RP)	.048	-.159 – .255	.648	Not Significant
Regional Funding Allocation (RF)	.033	-.170 – .236	.748	Not Significant

Regression model for Teaching Competence:

$$TC = 4.89 + .051(IA) + .242(ME) + .072(PD) - .378(CL) + .095(CI) + .349(MC) + .052(RT) + .048(RP) + .033(RF) + \varepsilon$$

Moreover, Table 6 displays the multilevel regression results for ALS mathematics teacher competence in teaching. The results show that mathematics efficacy ($\beta = .242$, $p < .024$), community linkages ($\beta = -.378$, $p < .012$), and mentoring and teamwork ($\beta = .349$, $p < .023$) are the significant predictors. The results show positive relationships of mathematics efficacy, mentorship, and collaboration. On the other hand, community linkages show a negative coefficient indicating an inverse relationship when holding other variables constant. The intercept ($\beta = 4.89$, $p < .001$) further indicates a high baseline level of teaching competence among ALS teachers.

Concerning the other predictors, no significant relationships were identified for instructional adaptability, professional development, curriculum implementation, and contextual factors. These results should be interpreted with caution because the number of higher-level units is low, which may affect the statistical power to detect effects in the multilevel model. As a result, it could be that the non-significant results do not imply that there is no influence, but rather may reflect the complex and interacting nature of these variables or limitations associated with study design. This suggests that these factors may still play meaningful roles in teaching competence, but their effects may not have been fully captured within the current model.

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Discussion

Teaching Competence among ALS Mathematics Teachers (RQ1)

The findings revealed that ALS mathematics teachers reported a high level of teaching competence in all dimensions. The highest mean score is in learning environment management, which indicates that ALS learners have a well-structured organization of the classroom and are consistently provided with support. The finding echoes the earlier work highlighting how crucial classroom management is to keeping teachers on task with instruction and learners engaged, especially in educational settings that do not have many resources to draw from (Flores, 2022; Francisco & Buri, 2024; Wilkins, 2022).

Pedagogical and content mastery, differentiated mathematics teaching, as well as assessment and feedback strategies, also received the highest proportion of ratings in achieving alignment across key dimensions of teaching practice. The teaching of mathematics in such diverse learning contexts needs to be responsive and adaptable to the needs of learners, as highlighted in other existing literature (Owusu et al., 2022; Paidi et al., 2021). These results indicate that ALS math teachers exhibited adaptive teaching for diverse learner archetypes. However, given that the data were extracted from perceptual and evaluative measures, results should therefore be interpreted as representative of perceived competence rather than direct indications of teaching competence.

Individual-Level Associations related to RQ2

Bivariate analyses revealed that instructional adaptability and mathematics teaching efficacy were positively associated with teaching competence. They are in line with the literature about the necessity of adaptive instructional strategies across flexible learning environments (Hardy et al., 2022; Mallillin, 2021) and provide further insight into the influence of teacher self-efficacy on their own instructional practice (Akosah et al., 2024; Olawale & Hendricks, 2024). In the ALS context, wherein learners diverge in both formal schooling and educational background, flexibility and certainty in mathematics teaching are significant individual traits associated with perceived competence.

The findings found no statistically significant association between professional development and teaching competence. Similar to preceding studies, sustaining professional development efforts with an anchor in particular school contexts and connection to teachers' practice may make the most positive difference for teachers (Kurteshi & Rutem, 2025; Parto & Yango, 2023). The lack of association in this study does not necessarily mean that professional development efforts were ineffective; to the contrary, professional development efforts may have indirect, long-term, or positive effects on teaching competence, conditional on how they are implemented and integrated into instructional practices.

Institutional-Level Associations Pertaining to RQ3

Bivariate analyses revealed that curriculum implementation, mentorship, and collaborative teaching were positively associated with teaching competence. These findings align with the existing literature, which emphasizes the importance of curricular coherence and structured professional collaboration in supporting teaching quality (Cordie et al., 2020; Haque & David, 2023; Lee et al., 2020). Within the ALS context, institutional mechanisms that promote alignment between curriculum expectations and collaborative teaching support appear to contribute to higher reported levels of teaching competence.

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Conversely, community linkages did not exhibit a statistically significant association with teaching competence at the bivariate level. This supports prior evidence which indicates that community involvement does not lead to classroom innovation, but rather bolsters access, pedagogical programs, and learner support systems (Caena & Redecker, 2019; Sompron, 2024). This distinction indicates that institutional engagement structures may operate differently from direct teaching support mechanisms when examined at a single level of analysis.

Regional-Level Associations Related to RQ4

Bivariate analyses demonstrated that capacity building and training programs, policy implementation and support, and funding and resource allocation were positively associated with teaching competence. This is congruent with previous studies, which point to systemic and structural support as central aspects impacting teacher performance, alongside teaching quality (Apriliyanti, 2020; Angrist et al., 2023; Schleicher, 2021). In the ALS context, the regional mechanisms that offer organized training, policy coherence, and resource allocation seem to be responsible for higher levels of perceived teaching competence.

Nevertheless, these associations are bivariate and cannot be interpreted as evidence for a direct causal effect. From a multilevel perspective, the broader institutional environment that affects classroom teaching practices may be affected by regional factors. Regional crossing structures are the enabling conditions that preserve teaching consistency, although their impact may not necessarily be a classroom-level phenomenon.

This distinction matters, especially in light of the multilevel analysis that follows and looks at the role of regional predictors within a nested structure reflecting the ALS educational context. Regional-level support is necessary, but its impact on teachers' competence is indirect, mediated through institutional and classroom conditions.

Multilevel Predictors Associated with RQ5

Findings showed that ALS teaching competence was shaped more by individual capabilities and institutional support mechanisms than by formal structures. Teachers who were more efficacious and adaptable in their approach to mathematics teaching reported greater levels of teaching competence. Furthermore, mentorship and collaborative teaching were identified as significant components that contribute to professional growth through co-constructive practices between peers in both flexible and resource-poor learning environments.

Notably, the finding of a negative association for the community linkages level indicated that greater engagement in the broader community exposed teachers to contextual challenges such as learner inconsistency, socio-economic constraints, and competing responsibilities. Although linkages to the community are needed for their support of programs, they seem to only indirectly influence teaching competence in context-dependent pathways. Overall, results suggest teaching competence in ALS is driven internally by capabilities and peer support, while external phenomena have more mediated effects.

The literature also supports these findings, highlighting that teacher ability interacts with collaboration and context to impact teaching competence. While teacher self-efficacy plays a role in providing clarity for the learning process and delivering an effective lesson plan, it does not mean you are competent; there are studies that suggest this effect is strong only when baseline competence exists (Perera & John, 2020). Mentorship in Collaborative Teaching Practices, like all areas of development, can help facilitate professional growth through collaborative practices where teachers collaborate and reflect on their teaching strategies with someone who provides helpful feedback and suggestions for refining the approach.

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However, the relationship of community linkages is complex. Research has indicated that engaged school-community relationships build professional judgment and reflective attention, particularly in disadvantaged settings (Tran & O'Connor, 2024). In a similar vein, broad exposure to professional practice within innovative and challenging learning contexts allows for deeper levels of pedagogical critical reflection and context-sensitive decision-making (Day & Gu, 2020). Such views are consistent with the current findings, which suggest that while community engagement does not necessarily lead to everything we can observe in terms of teaching competence, it supports teachers' ability to adapt and respond when confronted with complex learning environments.

Limitation of the Study

Despite its contributions, the study is subject to several limitations.

First, the descriptive–correlational research design limits the ability to establish causal relationships among the variables. Although statistically significant associations were identified at the individual, institutional, and regional levels, the temporal sequence and directionality of these relationships cannot be determined. Thus, the findings must be interpreted correlatively, not causally. Longitudinal or experimental designed future studies are needed to further explore the formation and development process of teaching competence in the ALS context.

Second, the studies were largely based on perceptual and evaluative measures of teaching competence and predictors. The study employed triangulated measures (self, peer, and head ratings) to enhance the validity of our measures; however, these data depicted perceived teaching expertise rather than the actual rating of classroom practice. Studies that include classroom observations, performance-based assessments, or learner outcome variables to validate teaching competence would provide more rigorous evidence moving forward.

Third, the research was limited to ALS mathematics teachers in six SDOs of Region X, Southern Philippines. Stratified random sampling of communities improved representativeness in the region, but contextual differences such as policy implementation, resource availability, and institutional structure may limit generalizability across other regions. External validity would be enhanced by replicating the study in more varied geographical and educational contexts.

Fourth, although multilevel modeling accounted for the hierarchical structure of dependency with teachers nested under institutions and regions, context variance may be poorly identified because of small higher-level clusters. The limited number of upper-level units may reduce statistical power to detect regional-level effects. Future studies involving larger and more diverse multi-regional samples are recommended to improve the robustness of multilevel analysis.

Conclusion and Implications

This study examined the teaching competence of ALS mathematics teachers in Region XI using a multilevel analytical approach. Findings indicated consistently high levels of teaching competence across key domains. However, results further showed that individual factors, such as instructional adaptability and mathematics teaching efficacy, and institutional factors, including curriculum implementation, mentorship, and collaborative teaching, were more strongly associated with teaching competence than other variables.

While some elements did not show direct relationships on certain levels, for example, professional development along with community linkages, this suggests that the influence of these factors is around how they are applied and placed in context. The multilevel analysis highlights that teaching competence is shaped not only by individual capability but also by the interaction of support systems within educational contexts.

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These findings provide empirical evidence for the need to investigate teaching competence at multiple levels, an area where previous single-level studies have fallen short. The results drive home, in a practical sense, that educational leaders should prioritize school-based support mechanisms, with greater emphasis on mentoring and collaboration, as well as on curriculum alignment. So they must also be specific to the context and practice-focused in order to be more effective.

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Declaration of Interest

The authors declare no competing interests.

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PROMOTING ENGAGEMENT AND LEARNING IN BASIC STATISTICS: IMPLEMENTING THE TEAMS-GAMES-TOURNAMENT APPROACH FOR GRADE 8 STUDENTS

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Abstract

Statistics is often perceived by students as abstract and complex, which leads to disengagement and poor comprehension. To address this challenge, the present study examined the effectiveness of the Teams-Games-Tournament (TGT) cooperative learning strategy in improving Grade 8 students' performance in basic statistics at Nueva Ecija University of Science and Technology, Gabaldon Laboratory High School. TGT integrates teamwork, competitive games, and tournaments with the goal of enhancing students' academic performance, engagement, and attitudes toward learning. A one-group pre-test-post-test quasi-experimental design and a descriptive correlational approach were employed, involving 37 purposively sampled Grade 8 students. Over six weeks, the students participated in TGT-based lessons, with data collected through pre-tests, post-tests, and engagement surveys. The results revealed a notable improvement in students' academic performance following the intervention. Student engagement was generally rated high, especially in activities involving collaborative learning, although relatively lower engagement was observed in inquiry-based tasks. Furthermore, a positive relationship was identified between student engagement and academic performance, emphasizing the importance of active participation in enhancing learning outcomes. The TGT effectively improves academic performance and engagement in basic statistics. However, individual variability in post-test results and lower engagement in inquiry suggest the need for strategies that foster questioning and equitable participation. This research contributes to pedagogical innovations, emphasizing statistical literacy as foundational for data-driven careers and higher-level analytical skills.

Keywords: *academic performance, basic statistics education, cooperative learning, statistical literacy, student engagement, teams-games-tournament (TGT)*

Introduction

Helping students make sense of data is more crucial than ever in an age where information is abundant and decisions are increasingly data-driven. Yet, for many Grade 8 students, learning basic statistics can feel overwhelming, often seen as abstract, difficult, and detached from their everyday experiences. This disconnect can lead to low engagement and poor comprehension of core statistical concepts. To address these challenges, educators must adopt innovative teaching strategies that transform statistics into an interactive, relatable, and meaningful subject. Mastering statistical concepts is fundamental in equipping students with the skills to analyze and interpret data effectively, an increasingly valuable competency in today's data-driven world (Nwala, 2023). However, teaching basic statistics to Grade 8 students poses unique challenges, as many learners perceive the subject as abstract, complex, and disconnected from their everyday experiences. This perception often results in a lack of interest

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and engagement, ultimately hindering their understanding of fundamental statistical principles. Addressing these challenges necessitates implementing innovative teaching strategies that foster interactive, engaging, and meaningful learning experiences. As highlighted by Razali et al. (2023), cultivating positive attitudes and enhancing students' confidence levels are essential for improving academic success in statistics courses.

The Teams-Games-Tournament (TGT) technique, initially developed by DeVries and Edwards (1972), is a cooperative learning strategy designed to address common educational challenges by fostering collaboration, active participation, and deeper understanding through cooperative problem-solving (Agustina et al., 2024; Capinding, 2021). TGT combines teamwork, competitive games, and structured tournaments to create a dynamic classroom environment that encourages peer interaction, enhances motivation, and makes learning more enjoyable and relevant (Matitaputty et al., 2023; Wiratama, 2024). By leveraging these social and competitive elements, TGT significantly improves students' conceptual understanding, problem-solving abilities, and academic performance (Bunag, 2024).

One of the primary advantages of TGT is its proven ability to enhance academic outcomes. Research demonstrates that implementing the TGT model can substantially improve students' performance. For instance, average student scores in mathematics increased from 61.48 to 86.78, with mastery rates rising from 40.74% to 85% (Isaloka et al., 2024). Similarly, a study focusing on multiplication topics reported a rise in mastery from 37.04% to 85.19%, showcasing significant gains in understanding and engagement (Maghfiroh et al., 2024).

The TGT model also plays a crucial role in increasing students' motivation and engagement (Luo et al., 2020; Putri et al., 2023). Its competitive and interactive nature, involving games and tournaments, creates an enjoyable and stimulating learning atmosphere (Vijayta & Isnawati, 2021). This environment encourages students to actively participate and engage more deeply with the content, as evidenced by studies where students' motivation levels improved from "Moderate" to "High" after TGT implementation (Pasaribu & Sihotang, 2024). In addition to academic and motivational benefits, TGT contributes to developing essential social and cooperative skills (Wulandari & Rosdiana, 2024). Through group interactions and collaborative activities, students enhance their teamwork and communication abilities (Nisa et al., 2024). These skills are crucial for academic success and preparing students for future collaborative endeavors and professional growth (Nisa et al., 2024).

On the other hand, there are several challenges in implementing the TGT related to classroom management, group dynamics, and practical implementation. One significant issue is the potential for increased noise levels and difficulties in managing the classroom environment, especially in larger or overcrowded settings. These factors can disrupt the flow of lessons and reduce their effectiveness, particularly when responsibilities and rewards are not distributed fairly among group members (Baydar, 2020). Additionally, the collaborative nature of TGT can sometimes lead to imbalances in group contributions, with more capable students dominating participation and overshadowing those who may require additional support to grasp the material (Ambarwati, 2014). This "domino effect" undermines the equitable engagement of all learners, a key goal of cooperative learning strategies. Another disadvantage lies in the challenge of dividing classes into balanced groups based on students' varying intelligence levels and learning paces. Creating equitable groupings that maximize the benefits of collaboration while minimizing disparities can be complex and time-consuming (Ambarwati, 2014). Furthermore, while TGT can be a valuable tool in teaching English and other subjects, its implementation demands substantial preparation and planning. Teachers must design engaging games, structure tournaments effectively, and anticipate potential disruptions. For some students, the cooperative aspects of TGT may not align well with their individual learning preferences, further complicating its success (Solekhah, 2020).

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Statistics education at the Grade 8 level is a critical foundation for higher-level mathematical and analytical skills. It equips students with tools to organize, summarize, and interpret data, which are essential for informed decision-making. Despite its importance, studies and classroom observations indicate that many students struggle with basic statistical concepts, such as measures of central tendency, probability, and data visualization. For example, the Grade 8 Laboratory High School students of Nueva Ecija University of Science and Technology Gabaldon Campus show a low engagement and performance in basic statistics as shown in their recent performance, where only 8.1% of the students got an outstanding performance, 13.51% got a very satisfactory performance, 27.02% got a satisfactory performance, and 51.35% got a fairly satisfactory performance (NEUST Gabaldon Laboratory High School, 2024). This was also notable in the PISA 2022 results, which show that in the Philippines, only 16% of students achieved at least Level 2 proficiency in mathematics, far below the OECD average of 69%, while almost none reached top levels (5 or 6), compared to the OECD average of 9%. These difficulties often stem from traditional teaching approaches that rely heavily on lectures and rote memorization, leaving little room for active learning and collaboration. According to Lapinid et al. (2022), there is a need to address students' social and psychological factors, requiring a deeper focus on making learning environments more effective.

Recognizing this problem, the present study aims to explore the implementation of the Teams-Games-Tournament (TGT) technique in teaching basic statistics to Grade 8 students. This classroom-based action research seeks to determine whether TGT can enhance student engagement, foster a positive attitude toward statistics, and improve their overall performance. By introducing a structured yet flexible approach that combines teamwork and competition, the research intends to make the learning process more accessible and enjoyable for students.

Furthermore, the study addresses the broader need for effective pedagogical practices that prepare students to meet the demands of the modern educational landscape. As statistical literacy becomes increasingly relevant across various fields, equipping learners with a strong foundation in statistics not only supports their academic success but also their future careers. By examining the potential of the TGT technique, this research contributes to the growing body of knowledge on innovative teaching methodologies and their impact on student learning outcomes.

Finally, the study aimed to provide educators with concrete insights into how the TGT approach might be incorporated into classroom procedures to improve engagement and learning in basic statistics, thereby setting the framework for a more engaging and successful learning environment. Specifically, this study intended to address the following questions: a.) How can the students' statistical performance be described before and after the TGT intervention? b.) Is there a substantial difference between the pre-test and post-test scores? c.) How should the general student's involvement in statistics be portrayed following the deployment of TGT? and d.) Is there a substantial association between the students' post-test scores and their overall involvement in statistics?

Research Methodology

Design

This study utilizes both a one-group pre-test and post-test quasi-experimental design and a descriptive correlational design. The one-group pre-test and post-test quasi-experimental design was used to evaluate the efficacy of the Teams-Games-Tournament (TGT) approach in teaching basic statistics to Grade 8 students. This design, a type of quasi-experimental research, involves assessing a single group of participants on the same dependent variable before and after a specific treatment or intervention (Choueiry, 2023). Specifically, a pre-test was administered

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to gauge students' initial understanding of basic statistics, followed by the implementation of the TGT approach, and then a post-test to measure improvements in their skills and engagement. The quasi-experimental nature of this design ensures its practical applicability in a classroom setting while providing data to assess the intervention's impact (Lam & Wolfe, 2023). Additionally, the descriptive correlational design was utilized to explore the relationship between students' post-test results and their general engagement in basic statistics. This design is used to identify and describe relationships between variables without manipulation, offering insights into their natural associations (Brodowicz, 2024).

Sampling Technique

This study utilizes purposive sampling to select participants. This method ensures that the sample includes students who are representative of the target population and possess characteristics relevant to the study's objectives (Andrade, 2021). Grade 8 students from a selected class were chosen based on their current performance in statistics and their availability to participate in the intervention.

Participants

The participants consisted of 37 Grade 8 students enrolled in a mathematics course that included a unit on basic statistics. This number was determined by the actual enrollment in the class, rather than being arbitrarily set. While the sample size is relatively small, it represents the complete population of students available in the selected class. Such naturally bounded samples are common in educational intervention studies and are considered valid as they reflect authentic classroom contexts. The group was also diverse in terms of mathematical abilities, which strengthens the reliability of the findings and supports the potential to generalize insights to similar learner populations.

Experimental Procedure

This study was conducted over six weeks (January 6 to February 14, 2025) and divided into three phases. During the Pre-Test Phase, a pre-test was administered to assess students' initial knowledge and skills in basic statistics. In the Intervention Phase, the TGT approach was applied in regular mathematics classes, where students were organized into teams and participated in lessons using teamwork, competitive games, and structured tournaments. Finally, in the Post-Test Phase, a post-test was conducted to evaluate improvements in students' statistical skills. Additionally, a questionnaire was administered to measure students' engagement in learning basic statistics.

Teams-Games-Tournament Procedure

According to Slavin (1995), the Teams Games Tournament (TGT) model promotes collaborative learning by organizing students into diverse groups of 4-6 members. The process involves forming groups, presenting the lesson, completing group worksheets, engaging in inter-group tournaments, and concluding with reflection and reinforcement. Similarly, Annurwanda (2018) outlines three key components of the TGT model: 1) Teams, where students are assigned to balanced groups based on academic ability; 2) Games, interactive activities designed to reinforce learning; and 3) Tournaments, where students compete individually to earn points for their teams, with the highest-scoring team declared the champion. Guided by the frameworks

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of Slavin (1995) and Annurwanda (2018), these principles were applied in the experimental procedure.

1. To form teams, the researcher divides the total number of students by six. In this case, since there are 37 students in the class, 37 ÷ 6 = 6 teams. Assign numbers sequentially, alternating direction (e.g., 1, 2, 3, 4, 5, 6, 6, 5, 4, 3, 2, 1). This method creates academically balanced, diverse teams while ensuring equal ability (Capinding, 2021).
2. There are four hours of class meetings each week. The first two hours are dedicated to pure discussion, employing the traditional teaching method where chalk and a chalkboard are used, supplemented by PowerPoint presentations. Students are encouraged to actively participate in classroom discussions. During this two-hour session, students' recitations are recorded as individual scores under the performance task category (Department of Education [DepEd], 2015).
3. The third hour is dedicated to collaboration with group mates, during which students practice the statistical skills taught in the first two hours of discussion. During this collaborative time, the highest-performing student(s) in the group, or their leader, tutors the lower-performing student(s). This one-hour team collaboration is also referred to as peer tutoring. Additionally, during this hour, students also practice the necessary skills required for the actual tournament (Capinding, 2022).
4. The fourth hour is dedicated to the actual tournament, where teams compete in a game. In these games, students participate either individually or as a group. Individual scores contribute to the overall team score, fostering personal accountability and effort (Patil et al., 2023). Additionally, the competitive nature of the tournament motivates students to collaborate, share knowledge, and support one another in achieving common goals (Astuti et al., 2022).
5. After the tournament, the winning group received recognition, and the "Most Performing Player of the Week" was also acknowledged. The winning group and top-performing student(s) were awarded prizes, such as chocolates, snacks, and/or toys. Students or groups who did not win were given consolation prizes. Additionally, the winning team and the most performing player were featured on the TGT board.

Prizes serve to stimulate student interest and engagement, making learning more enjoyable (Faysal et al., 2023). Similarly, students in game-based learning environments who receive rewards demonstrate higher motivation and better educational outcomes compared to those who do not (Duisenova & Zhorabekova, 2024). Furthermore, rewards can act as catalysts, helping students shift from extrinsic to intrinsic motivation and ultimately fostering a genuine love for learning (Sigalingging et al., 2023).

Games and Game Procedures

The TGT sessions featured a variety of games designed to reinforce statistical concepts, including summation notation, measures of central tendency, quantiles, measures of dispersion, and the coefficient of variation. Some games were adapted and modified to incorporate statistical questions while the researcher developed others. Below is a list of games implemented during the tournament.

1. The Ball Asks is a game adapted from SantoPixel (2024). To begin, all students form a circle, and music is played while a ball is passed around. When the music stops, the student holding the ball must answer a question. A correct answer earns the student 3 points, which are added to their team's total. If the student answers

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incorrectly, another team has the opportunity to "steal" and respond. A correct answer by the stealing team earns them 2 points. If no team answers correctly, the game continues, with the music resuming.

2. The Squid Game is a highly popular Korean series. A variation of this game was adapted for an activity involving students. The researcher recruited six students from higher grade levels to act as "Young-hee." The objective of the game was for participants to retrieve questions located behind the six "Young-hee" and answer them correctly.
   Students had to approach the "Young-hee" stealthily to avoid being noticed. If a participant was seen or noticed by "Young-hee," they were immediately eliminated from the game. If a student successfully retrieved a question without being detected and answered it correctly, their team earned three points. However, if the question was answered incorrectly, the participant was eliminated. The team with the highest score at the end of the activity was declared the winner of the week.
3. "Family Feud," an American TV icon since 1976 with Richard Dawson as its first host, features dueling families and the famous phrase, "Survey says!" Despite changes in hosts, cancellations, revivals, and syndication, it remains popular with loyal fans while attracting new ones.
   In the main game of "Family Feud," one member from each team faces off to answer the first question. The first to buzz in gives an answer; if it's the top response, their family gains control. Otherwise, the other contestant tries to provide a better answer to win control.
   The winning family guesses the remaining answers without consulting each other. Incorrect answers earn strikes, and three strikes transfer control to the opposing team, who gets one chance to guess correctly and win the round. Typically, four rounds are played, with additional sudden-death rounds if time permits (Kelly et al., 2024).
4. Tied up game. Divide participants into teams of 6. Form circles with team members facing each other and tie their wrists to their neighbors using rope or strings. Each team must then complete and answer the given questions together while their hands remain tied (Toggle Track, 2024).
5. The "Pop the Balloon" game features six teams of six members each, competing to answer questions hidden in balloons and earn points. Teams take turns popping a balloon, retrieving the question, and answering it within 30 seconds. Correct answers earn 10 points, while incorrect ones earn none. The game proceeds in rotation, ensuring equal turns for all teams. The team with the highest score wins, with a tiebreaker round if necessary. Participants must remain respectful and avoid outside assistance. The facilitator ensures fair play and accurate scoring in this fun, team-based activity (Indoor Party Games, 2024).
6. Statistical Race. This game challenges participants to solve statistical problems in the shortest possible time. There will be four different stations, located both inside and outside the room, each containing a specific question that teams must answer correctly. The team that completes all stations in the shortest time will be declared the winner.

Materials and Instruments

The researcher employed two essential tools in this study. A 50-item test was developed by the researcher for both the pre-test and post-test to assess the participants' knowledge and skills. While the items in the pre-test and post-test were similar in difficulty, they were not identical. Additionally, a questionnaire designed to measure general student engagement in learning basic statistics was also created by the researcher. The questionnaire used a 4-point

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Likert scale with the following response options: 4 (strongly agree), 3 (agree), 2 (disagree), and 1 (strongly disagree).

Validity of Test Questions and General Student Engagement

To ensure the validity of the test items and the questionnaire on general student engagement in learning basic statistics, the researcher utilized the Lawshe (1975) method. This approach involves expert evaluation of each item's relevance to the construct being measured. The researcher enlisted the assistance of 10 mathematics faculty members from NEUST to review and rate each item in the test questions and the Likert scale questionnaire. Each item was assessed based on its essentiality, with ratings used to compute the Content Validity Ratio (CVR) using the formula: $CVR = [ne-(N/2)]/(N/2)$, where *ne* represents the number of panelists rating the item as "essential," and *N* is the total number of panelists. Items that achieved a minimum CVR of 0.667, as required for a panel of 12 experts, were considered valid and relevant for inclusion in the test and questionnaire (Ayre & Scally, 2014). This process ensured the reliability and appropriateness of the tools for assessing knowledge, skills, and engagement in basic statistics.

Table 1 shows that the Content Validity Ratio (CVR) for the items in the pre-test and post-test ranges from .667 to 1.00, exceeding the critical value of .667. Similarly, the Content Validity Index (CVI) for these items is .863, which is also above the critical threshold of .667. Likewise, the CVR for the General Engagement Questionnaire for Statistics (GEQS) ranges from .667 to 1.00, with a CVI of .833, both surpassing the critical value of .667. Based on these results, the pre-test, post-test, and GEQS are deemed valid.

Table 1
Content Validity of Test Questions and Questionnaire

	Content Validity Ratio Ranges	Content Validity Index (CVI)	Critical Value	Interpretation
Pre-test and Post-test	.667 – 1.00	.863	.667	Valid
General Engagement Questionnaire (GEQS)	.667 – 1.00	.833	.667	Valid

Item-Analysis

Table 2 presents the ranges of the difficulty index and discriminating power for each item in the pre-test and post-test. The difficulty index for the pre-test ranges from .43 to .53, while that of the post-test ranges from .43 to .67, indicating that the items for both tests are of average difficulty. Additionally, the discriminating power for the pre-test ranges from .38 to .50, and for the post-test, it ranges from .38 to .63. Both ranges are interpreted as reflecting very good item quality.

Table 2
Difficulty Index and Discriminating Power

	Ranges of Difficulty Index	Difficulty	Ranges of Discriminating Power	Interpretation
Pre-test	.43-.53	Average	.38-.50	Very Good Items
Post-test	.43-.67	Average	.38-.63	Very Good Items

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Reliability of Instruments

Table 3 presents the Cronbach's alpha values for the pre-test and post-test as .91 and .90, respectively, which indicate excellent reliability. The General Engagement Questionnaire for Statistics (GEQS) yielded a Cronbach's alpha of .88, signifying good reliability. These findings suggest that the pre-test, post-test, and questionnaire possess strong internal consistency (Middleton, 2019). Furthermore, the alpha values remain below .95, implying that the items are sufficiently distinct and not overly redundant (Frost, 2023).

Table 3
Reliability of Test Questions and Questionnaire

	Cronbach's alpha	Interpretation
Pre-test	.91	Excellent
Post-test	.90	Excellent
General Engagement Questionnaire (GEQS)	.88	Good

Data Collection

The researcher respectfully sought permission from the principal of the Laboratory High School and the Campus Director of the Nueva Ecija University of Science and Technology, Gabaldon Campus, to conduct the study. During the initial meeting, the pre-test was administered to assess the students' knowledge and skills in basic statistics, serving as baseline data for the experiment (All et al., 2017). Following a six-week intervention using the Teams-Games-Tournament approach, the post-test was administered to evaluate the students' learning in basic statistics. Additionally, the general questionnaire on students' engagement in basic statistics was distributed to gather further insights.

Data Analysis

The data analysis utilized both descriptive and inferential statistical techniques. Descriptive statistics, such as the mean and standard deviation, were used to summarize the pre-test and post-test results, along with students' engagement levels. For inferential analysis, a paired sample t-test was conducted to assess whether the improvement in post-test scores compared to pre-test scores was statistically significant. Moreover, the Pearson correlation coefficient (r) was applied to explore the association between engagement levels and post-test performance, offering insights into how engagement may influence learning outcomes.

Normality Test

Table 4 indicates that the pre-test ($W = .973$, $p > .05$), post-test ($W = .917$, $p > .05$), and the General Engagement Questionnaire ($W = .905$, $p > .05$) are normally distributed. Hence, the t-test for correlated samples and Pearson's correlation coefficient were utilized for data analysis.

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Table 4
Normality Test

Data Sources	Shapiro-Wilk		
	W	*df*	*p*
Pre-test	.973	37	.491
Post-test	.917	37	.309
General Engagement Questionnaire (GEQS)	.905	37	.314

Research Results

Pre-test and Post-test Results

Table 5 presents the descriptive statistics for the pre-test and post-test scores of Grade 8 students in basic statistics conducted before and after the implementation of the Teams-Games-Tournament (TGT) intervention. The average score in the pre-test was 11.59, with a standard deviation of 4.33, indicating relatively low initial performance with moderate variability among the 37 students. After the intervention, the post-test average increased to 31.43, with a higher standard deviation of 7.43. This indicates a substantial improvement of approximately 20 points in the mean score, though the increased variability suggests that some students benefited more from the intervention than others.

Table 5
Descriptive Statistics for Pre-test and Post-test

Test Before and After TGT	*M*	*MD*	*N*	*SD*
Pre-test	11.59	19.84	37	4.33
Post-test	31.43		37	7.43

Paired Sample t-test for Pre-test and Post-test

The table displays the results of a paired sample t-test comparing Grade 8 students' pre-test and post-test scores in basic statistics after implementing the Teams-Games-Tournament (TGT) strategy. A correlation coefficient of .850 indicates a strong positive relationship, suggesting that students who scored well on the pre-test also tended to do well on the post-test. The p-value ($p < .01$) shows that the improvement in scores is statistically significant. The t-value ($t = -27.502$, $p < .01$) further supports this significant difference, with the negative sign indicating higher post-test scores. Moreover, a *Cohen's d* of 4.52 suggests a very large effect size, underscoring the notable educational impact of the TGT intervention.

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Table 6.
Paired Sample t-test for Pre-test and Post-test

	Correlation	*p*	*t*	*df*	*p* (2-tailed)	*Cohen's D*	Effect Size
Pre-test & Post-test	.850	< .001	-27.502	36	< .001	4.52	Large Effect

General Engagement of Students in Basic Statistics After the TGT Intervention

After implementing the Teams-Games-Tournament (TGT) strategy as an intervention, the data revealed a significant level of student engagement in basic statistics, as reflected in the overall weighted mean of 3.38, verbally interpreted as "Strongly Agree." The strategy appears to have effectively fostered collaboration and teamwork, with the highest mean score of 3.54 observed in students' collaboration with classmates to solve statistical problems. This indicates that the TGT approach successfully promoted interactive and cooperative learning among students.

Additionally, students showed strong engagement in various aspects of the learning process, such as actively participating in discussions (3.49), applying statistical knowledge to real-world situations (3.35), and enjoying the challenge of working on statistical problems (3.46). These results suggest that the TGT strategy enhanced their motivation and interest in learning basic statistics. However, the lowest mean score of 3.16, corresponding to asking questions during lessons, indicates that while engagement improved overall, there remains room for growth in encouraging students to clarify concepts through active questioning.

The variability in responses, as indicated by standard deviations ranging from 0.50 to 0.80, further suggests that students experience differing levels of impact. The highest variability was seen in the aspect of asking questions (0.80), potentially reflecting differences in confidence or willingness to participate in this way. Overall, the data suggest that the TGT strategy positively influenced student engagement, particularly in collaborative and applied learning, while emphasizing the need to create an environment that further supports inquiry and clarification during lessons.

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Table 7
General Engagement Questionnaire (GEQS)

General Students' Engagement in Basic Statistics	*M*	*SD*	Verbal Interpretation
1. I actively participate in class discussions about basic statistics.	3.49	0.56	Strongly Agree
2. I regularly complete assignments and activities related to basic statistics on time.	3.30	0.70	Strongly Agree
3. I feel motivated to learn and understand statistical concepts.	3.41	0.50	Strongly Agree
4. I collaborate with my classmates to solve statistical problems.	3.54	0.56	Strongly Agree
5. I find the topics in basic statistics interesting and engaging.	3.30	0.74	Strongly Agree
6. I ask questions during lessons to clarify my understanding of statistical concepts.	3.16	0.80	Agree
7. I use additional resources (e.g., books, videos, or online tutorials) to enhance my learning of basic statistics.	3.27	0.65	Strongly Agree
8. I apply the knowledge I learn in basic statistics to real-world situations or other subjects.	3.35	0.59	Strongly Agree
9. I enjoy working on statistical problems, even when they are challenging.	3.46	0.65	Strongly Agree
10. I feel that my instructor's teaching methods encourage my active participation in learning statistics.	3.57	0.55	Strongly Agree
Total Weighted Mean	**3.38**	**0.64**	**Strongly Agree**

Correlation Between Post-test Results and Students' General Engagement in Basic Statistics

Table 8 shows that the relationship between the post-test results and students' engagement in basic statistics is highly significant *(r* = .518, $p < .01$). The positive relationship suggests that higher levels of student engagement, fostered by the TGT intervention, are associated with improved academic performance.

Table 8
Correlation of Engagement and Scores in Basic Statistics

		General Engagement
Post-test	Pearson *r*	.518**
	p-value (2-tailed)	.001
	N	37

Discussion

The large mean difference of 19.84 suggests that the TGT approach equipped with different games had a positive impact on the students' performance in basic statistics. These

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results highlight the effectiveness of active and collaborative learning strategies, as the TGT intervention likely made the learning process more engaging and interactive, thereby enhancing understanding and retention. Similarly, Hasibuan et al. (2022) found that the Teams Games Tournament (TGT) learning model, when paired with general media and cooperative learning, increased student learning outcomes in biology. This finding supports the view that TGT is an effective strategy for enhancing student achievement across different subject areas. Comparable results have also been reported internationally, where game-based and cooperative learning methods enhanced students' cognitive outcomes and motivation in mathematics and science education (Hui & Mahmud, 2023). However, the higher variability in the post-test scores in the present study implies that individual differences may have influenced how students responded to the intervention, a challenge also noted in cross-cultural contexts.

The results clearly indicate that the TGT intervention was highly effective in improving students' performance in basic statistics. The strong correlation suggests that the method worked consistently across students with varying initial skill levels, while the large effect size emphasizes the magnitude of the improvement. The statistically significant increase in scores supports the idea that the TGT approach, which incorporates active and collaborative learning, enhances students' understanding and engagement in the subject matter. Likewise, the Teams Games Tournament (TGT) cooperative learning model has been found effective in ecosystem education (Ghaemi et al., 2023) and in mathematics classrooms in Indonesia (Wahjusaputri et al., 2024). These findings are consistent with research in other fields; for example, Bhat et al. (2020) reported that TGT boosted performance and collaboration in engineering students, while Syaifuddin et al. (2020) highlighted its benefits in improving students' learning outcomes in Civics Education.

These findings have important implications for educational practices. The substantial improvement in post-test scores demonstrates the value of interactive and student-centered teaching methods like TGT in fostering meaningful learning (Saputri & Sukmawati, 2024). Moving forward, educators could consider applying similar strategies to other subjects to achieve comparable outcomes. However, future studies could also explore the variability in individual responses to the intervention to ensure its effectiveness for all learners. Overall, the TGT intervention appears to be a transformative approach to improving academic performance in statistics. Similarly, Wahjusaputri et al. (2024) show that team-assisted Individualization and Team Games Tournament models effectively improve academic achievement and engagement in seventh-grade Math students. Comparable findings are also reported by Fonseca et al. (2023), where cooperative game-based learning significantly improved student engagement and problem-solving skills.

Furthermore, the results highlight the effectiveness of the Teams-Games-Tournament (TGT) strategy in enhancing student engagement in basic statistics. The findings underscore the significant impact of this cooperative learning approach, with students showing the highest engagement in collaborative learning, particularly when working with classmates to solve statistical problems. This suggests that the TGT strategy successfully fostered teamwork and a sense of community, which are essential elements of interactive learning (Capinding, 2021). Comparable studies confirm that fostering teamwork through structured competition improves not only academic achievement but also communication and social interaction skills (Amri et al., 2025).

Additionally, the strategy improved students' active participation in discussions, motivation to apply statistical knowledge to real-world contexts, and enjoyment in tackling statistical problems. These outcomes indicate that the competitive yet cooperative nature of the TGT strategy effectively stimulated interest and sustained engagement in the subject. By integrating games and tournaments into the learning process, students likely found the activities more engaging, which contributed to their overall positive experience. Similar conclusions

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were drawn by Peña et al. (2024), who found that structured competition enhanced students' motivation and classroom participation in U.S. settings.

However, the results also reveal an area for improvement. Students demonstrated less confidence in asking questions during lessons, indicating that while the TGT strategy encouraged other forms of engagement, it did not fully address students' hesitation to seek clarification. The variability in this area reflects differences in comfort levels, suggesting the need for targeted efforts to support inquiry and active questioning. This limitation aligns with findings from international studies where game-based learning improved collaboration and motivation but was less effective in promoting critical questioning and inquiry (Capinding & Salazar, 2023).

Furthermore, the findings demonstrate that the TGT strategy is a valuable tool for promoting engagement in basic statistics, particularly in enhancing collaboration, participation, and motivation. Future implementations could incorporate activities or incentives that specifically encourage students to ask questions and seek clarification during lessons. Creating a classroom environment that normalizes and values inquiry can further enhance the effectiveness of the strategy and support all students in their learning journey. On the other hand, according to Fortepiani (2023), game-based learning strategies increased student engagement and perception of learning but did not significantly improve academic performance in Health Professions education. Similarly, Yu et al. (2020) stated that educational games have the potential to improve student engagement and satisfaction, but their impact on learning outcomes depends heavily on the game's design and implementation. Consequently, the design of this TGT, incorporating various games, appears particularly effective in improving students' performance in statistics while also boosting their engagement.

The moderate positive correlation suggests that as students' engagement in learning activities increases, their academic performance in basic statistics also improves. This relationship highlights the effectiveness of the Teams-Games-Tournament (TGT) intervention in promoting active participation, collaboration, and motivation among students. By making the learning process interactive and enjoyable, the TGT strategy likely encouraged students to invest more effort and interest in their studies, resulting in better academic outcomes. Likewise, according to Nisa et al. (2024), the Team Games Tournament (TGT) learning model positively impacts student mathematics learning outcomes by increasing motivation, engagement, and understanding while developing social and cooperative skills. However, not all studies align; Tejada-Simon (2024) found that game-based learning enhances engagement but does not directly improve grades in higher education, which suggests that context and implementation are critical factors.

Ultimately, these findings reinforce the value of implementing innovative teaching strategies, such as TGT, that emphasize engagement and active learning. Furthermore, the significant correlation suggests that enhancing student engagement should be a priority in instructional planning, as it directly impacts academic success. Future interventions can build upon these results by further optimizing engagement strategies to maximize both learning experiences and performance outcomes.

Conclusions and Implications

This study contributes to closing the gap in empirical research on the effectiveness of structured game-based collaborative strategies, such as the Teams-Games-Tournament (TGT) approach, in teaching statistics. While active and collaborative learning methods have been widely advocated, limited evidence exists on how combining them with competitive, game-based elements can influence both cognitive and affective learning outcomes in quantitative subjects. The findings demonstrate that TGT significantly improves students' performance in basic statistics, with a large mean difference, strong correlation, and substantial effect size,

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underscoring its effectiveness. Beyond academic gains, the strategy fostered engagement, teamwork, and motivation, creating a dynamic classroom environment that supported students across varying skill levels. However, the persistent challenge in students' confidence to ask questions highlights the need for complementary interventions to strengthen inquiry skills and classroom discourse. These findings suggest that integrating TGT into teaching practice can enhance learning effectiveness in statistics education, while also pointing to the importance of designing supportive structures that encourage student questioning and critical thinking.

Recommendations

Educators are encouraged to incorporate the TGT strategy into their teaching practices, not only for statistics but also for other subjects where active and collaborative learning can be beneficial. To maximize the effectiveness of the approach, efforts should focus on designing activities that balance competitive and cooperative elements, ensuring sustained student interest and participation. Additionally, future implementations of the TGT strategy should address students' hesitation to seek clarification by fostering a classroom culture that values inquiry and critical thinking. This can be achieved through targeted activities, such as structured questioning sessions or incentives for active participation. Researchers are also encouraged to investigate the variability in students' responses to the TGT approach and explore its application in diverse educational contexts to ensure inclusivity and consistency in its impact.

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TEACHERS' ADOPTION OF GAMIFICATION AND SIMULATION-BASED LEARNING IN SCIENCE EDUCATION: AN EXTENDED UTAUT2 MODEL

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Abstract

The rapid advancement of digital technologies has intensified interest in innovative educational approaches such as gamification and simulation-based learning (GSBL) in science education. Despite their documented pedagogical benefits, teachers' adoption of these approaches remains limited. This study examines the determinants of in-service science teachers' intention to use GSBL through the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2). A cross-sectional survey design was employed with a sample of 800 in-service science teachers who participated in a structured professional development program. Structural equation modeling (SEM) was used to test the proposed research model and hypotheses. The results indicate that performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit significantly predict teachers' behavioral intention to adopt GSBL. The findings contribute to the literature by validating UTAUT2 in the context of science education and by offering practical implications for policymakers, teacher educators, and school administrators seeking to promote technology-enhanced pedagogies.
Keywords: *gamification, simulation-based learning, UTAUT2, science education, teacher adoption, technology acceptance*

Introduction

The rapid digital transformation of education has intensified long-standing pedagogical challenges in science education, a domain characterized by abstract concepts (e.g., atomic structures and energy transfer), invisible phenomena (e.g., molecular interactions), and potentially hazardous experimental processes (Nkadimeng & Ankiewicz, 2022). These characteristics often limit students' opportunities for direct experimentation and conceptual modeling in real classroom settings. In response, contemporary science education frameworks, including inquiry-based learning (IBL) and the 5E educational model, emphasize active exploration, hypothesis generation, experimentation, and evidence-based reasoning as central components of meaningful science learning (Morris, 2025). However, despite their pedagogical promise, such approaches are frequently constrained by practical limitations related to time, safety, material resources, and students' prior knowledge (Limbere et al., 2022).

Within this context, technology-enhanced educational approaches have been increasingly positioned as potential means of supporting inquiry-oriented science education. In particular, simulation-based learning and gamification have gained prominence due to their capacity to create interactive, learner-centered environments that foster exploration and experimentation (Monauni & Götte, 2022). Simulation-based learning enables students to manipulate variables, test hypotheses, and visualize otherwise inaccessible scientific phenomena in safe and repeatable digital environments (Sun et al., 2022). Gamification, by contrast, embeds motivational design elements such as challenges, feedback, and progression systems into learning activities, aiming

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to sustain students' engagement during cognitively demanding inquiry processes (Ateş & Polat, 2025a; Bennani et al., 2022). Although pedagogically distinct, both approaches serve a common function in science education by mediating inquiry through interactive digital environments that support exploration, experimentation, and sense-making (Kefalis et al., 2025; Na et al., 2025).

Despite their increasing availability and strong alignment with inquiry-based pedagogies, the classroom adoption of gamification and simulation-based learning (GSBL) remains uneven. Empirical evidence suggests that the success of such approaches depends less on their technological sophistication and more on teachers' perceptions, beliefs, and educational intentions (Ateş & Kölemen, 2025a). As key pedagogical decision-makers, science teachers ultimately determine whether these tools are meaningfully integrated into inquiry-oriented education or remain peripheral add-ons. In practice, teachers frequently report challenges related to pedagogical alignment, perceived educational value, classroom feasibility, and institutional support, particularly within the demanding context of science curricula (Hu et al., 2025).

Although a substantial body of research has documented the positive effects of GSBL on student motivation and conceptual understanding (Ateş & Kölemen, 2025b; Bouriami et al., 2025), their sustained adoption by in-service science teachers has not kept pace with technological advancement. Moreover, existing research has predominantly examined GSBL from a learner-centered perspective, focusing on student outcomes rather than the educational decision-making processes of teachers (Thi Binh et al., 2025). Studies that do address teacher adoption often conceptualize technology acceptance as a generic phenomenon, overlooking the domain-specific demands of science teaching, such as inquiry facilitation, experimentation, and conceptual modeling (Özdemir & Ateş, 2025). Consequently, there remains limited empirical understanding of why science teachers choose to adopt, or refrain from adopting, GSBL as integral components of inquiry-oriented science education.

Based on the research problem outlined above, this study examined in-service science teachers' intentions to adopt GSBL through a theory-driven model and addressed specific research questions and hypotheses derived from the UTAUT2 framework.

Literature Review

Gamification and Simulation-Based Learning in Science Inquiry

Research on technology-enhanced science education consistently highlights the potential of GSBL to support inquiry-oriented pedagogies rather than merely increasing surface-level engagement (Cheng et al., 2024; Tassilova et al., 2025). In science education, learning is inherently linked to processes such as hypothesis generation, variable manipulation, evidence-based reasoning, and conceptual modeling (Malone, 2023). Digital simulations have been shown to be particularly effective in supporting these processes by allowing learners to visualize invisible phenomena, test causal relationships, and iteratively refine their understanding in ways that are difficult to achieve through traditional education alone (Pang et al., 2024). Empirical studies in physics and chemistry education demonstrate that simulations can reduce misconceptions by making abstract processes such as molecular motion or electric fields explicit and manipulable, thereby supporting conceptual change (Feyzioğlu, 2009).

Gamification, while pedagogically distinct from simulations, complements inquiry-based science learning by sustaining students' engagement during cognitively demanding tasks (Zourmpakis et al., 2024). Research indicates that game design elements such as immediate feedback, progression systems, and goal structures can encourage persistence in problem-solving and experimentation, particularly in complex scientific investigations (Machmud et al., 2023). When embedded within inquiry activities, gamification has been found to support formative assessment practices and to motivate students to engage more deeply with scientific reasoning tasks (Morris et al., 2013).

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Despite these pedagogical affordances, the integration of GSBL in science classrooms remains uneven. Prior research has identified barriers related to curricular alignment, time constraints, teachers' perceived workload, and limited professional support (Hora, 2016). Importantly, these barriers are not merely technical but pedagogical in nature, underscoring the need to examine teachers' adoption decisions through a theory-driven lens that accounts for educational value, effort, and contextual constraints (Tseng et al., 2022).

Adapting UTAUT2 for Teachers in Science Education

The UTAUT2 has been widely employed to explain technology adoption in voluntary usage contexts (Tamilmani et al., 2017). While the model offers a comprehensive set of determinants influencing behavioral intention, its original formulation reflects consumer-oriented assumptions that do not fully align with school-based teaching environments. In K–12 education, technology adoption is shaped by institutional expectations, pedagogical accountability, and collective norms rather than individual consumer choice alone (Du & Liang, 2024).

In the context of science education, performance expectancy extends beyond general job efficiency to encompass perceived pedagogical value, specifically, whether a technology enhances inquiry processes, supports conceptual understanding, and aligns with curriculum standards (Ateş & Gündüzalp, 2025). Studies examining teachers' adoption of digital laboratories and simulations consistently report performance expectancy as a primary determinant when technologies demonstrably improve students' understanding of complex scientific concepts (Nzabahimana et al., 2024).

Effort expectancy, by contrast, is closely tied to teachers' workload and time pressures. Science teachers often balance laboratory preparation, assessment demands, and classroom management, making perceived complexity a critical factor in adoption decisions. Research suggests that even pedagogically powerful tools are likely to be rejected if they are perceived as difficult to implement or disruptive to established educational routines (Ranellucci et al., 2020).

Social influence in school settings is frequently manifested through school leadership expectations, peer collaboration, and professional learning communities rather than informal social norms (Liou & Daly, 2020). Empirical evidence indicates that administrative support and peer modeling play a significant role in shaping teachers' willingness to experiment with innovative educational technologies, particularly in science departments where collaborative planning is common (Ateş & Polat, 2025b).

Facilitating conditions are especially salient in science education due to the infrastructural demands of laboratory-based education (Jere & Mpeta, 2024). Access to reliable internet connectivity, suitable devices, and technical support has been shown to condition whether teachers can realistically integrate simulations or gamified platforms into inquiry activities (Vetrivel et al., 2024).

UTAUT2 constructs related to affective and evaluative dimensions also require contextual reinterpretation. Hedonic motivation, in educational contexts, reflects not only enjoyment but also teachers' intrinsic satisfaction derived from observing students' engagement and conceptual growth. Prior studies suggest that teachers who perceive technology use as professionally rewarding are more inclined to sustain its use (Ateş & Garzón, 2022).

Crucially, this study reconceptualizes price value to address the educational context. Rather than monetary cost, price value is interpreted as perceived educational return on investment, namely, teachers' judgments regarding whether the pedagogical benefits of GSBL justify the time, preparation effort, and classroom resources required (Ateş & Kölemen, 2025a). This interpretation aligns with findings that teachers frequently evaluate technologies in terms of educational payoff rather than financial expenditure.

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Finally, habit is conceptualized as routine engagement with digital educational tools rather than habitual use of gamification or simulations specifically (Gómez-García et al., 2020). Teachers with established digital teaching routines have been shown to integrate new technologies more readily, suggesting that habitual technology use may lower adoption thresholds for GSBL. In the present study, habit therefore reflects teachers' general digital teaching routines and contextual readiness for technology integration, rather than post-adoption inertia associated with continued use of GSBL. Prior research indicates that teachers with established digital instructional routines are more likely to experiment with and integrate new educational technologies, suggesting that habitual technology use may lower psychological and practical thresholds for the adoption of GSBL.

Despite the growing body of research highlighting the pedagogical affordances of GSBL in inquiry-oriented science education, existing studies have predominantly focused on student-level outcomes, offering limited insight into teachers' educational decision-making processes. Moreover, research examining teachers' adoption of GSBL has often treated technology acceptance as a generic phenomenon, insufficiently accounting for the domain-specific demands of science teaching, such as inquiry facilitation, experimentation, and conceptual modeling. Although UTAUT2 provides a robust framework for understanding technology adoption, its application in K–12 science education remains under-theorized, particularly with respect to contextual reinterpretations of key constructs. Consequently, there is a clear need for a theory-driven and context-sensitive investigation into the factors shaping in-service science teachers' intentions to adopt GSBL within inquiry-based science education.

Research Aim and Research Questions

The aim of this study was to examine the mechanisms underlying in-service science teachers' intentions to adopt GSBL within inquiry-oriented science education. Specifically, this study addressed how cognitive (e.g., performance expectancy), affective (e.g., hedonic motivation), social (e.g., social influence), and contextual (e.g., facilitating conditions) determinants shaped teachers' adoption intentions within a contextually adapted UTAUT2 framework.

Accordingly, the study addressed the following research questions:

1. To what extent did the proposed UTAUT2-based model explain in-service science teachers' intentions to adopt GSBL within inquiry-oriented science education?
2. How well did a contextually adapted UTAUT2 model fit the empirical data in explaining science teachers' adoption intentions?

Hypothesis Development

Performance Expectancy and Inquiry Support

In science education, teachers prioritize educational approaches that enhance students' ability to engage in inquiry, experimentation, and evidence-based reasoning (Brown et al., 2010). Technologies that demonstrably improve conceptual understanding and inquiry efficiency are therefore more likely to be adopted (Bumbacher et al., 2018). Prior studies on digital simulations and virtual laboratories indicate that perceived educational effectiveness is a strong predictor of teachers' adoption intentions (Tarmo, 2022). Accordingly, this study posits:
H1: Performance expectancy positively affects science teachers' intention to adopt GSBL.

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Effort Expectancy and Teacher Workload

Given the intensive preparation demands associated with science teaching, perceived ease of use plays a critical role in technology adoption (Moses et al., 2013). Tools that are perceived as complex or time-consuming are often avoided, regardless of their pedagogical potential. Empirical evidence suggests that lower perceived effort increases teachers' willingness to integrate technology into regular education (Sang et al., 2023). Therefore:
H2: Effort expectancy positively affects science teachers' intention to adopt GSBL.

Social Influence and School Culture

Technology adoption in schools is strongly embedded within organizational culture. Support from school leadership and encouragement from colleagues can legitimize experimentation with innovative pedagogies (Stumbrienė et al., 2024). Studies in K–12 contexts indicate that peer modeling and administrative endorsement significantly influence teachers' educational decisions (Lai et al., 2022). Thus, it is hypothesized that:
H3: Social influence positively affects science teachers' intention to adopt GSBL.

Facilitating Conditions

The successful integration of GSBL in science classrooms depends on the availability of technological and organizational support. Adequate infrastructure and technical assistance reduce implementation barriers and increase teachers' confidence in using digital tools (Wangdi et al., 2023). Accordingly:
H4: Facilitating conditions positively affect science teachers' intention to adopt GSBL.

Hedonic Motivation

Teachers' intrinsic enjoyment and professional satisfaction derived from using technology can influence their adoption decisions (Ateş & Garzón, 2022). When GSBL tools enhance classroom dynamics and student engagement, teachers may experience greater educational enjoyment, which in turn supports sustained use. Therefore:
H5: Hedonic motivation positively affects science teachers' intention to adopt GSBL.

Price Value as Educational Return on Investment

In educational settings, teachers evaluate technologies based on whether the educational benefits outweigh the required investment of time and effort (Hernández-Leo & Ginoyan, 2025). When GSBL is perceived as yielding substantial learning gains relative to preparation demands, adoption is more likely. Consequently:
H6: Perceived educational return on investment (price value) positively affects science teachers' intention to adopt GSBL.

Habit and Technological Routine

Teachers with established routines of using digital technologies are more inclined to experiment with new educational tools (Liu et al., 2025). Habitual engagement with educational technologies can reduce uncertainty and lower perceived adoption barriers. Hence:
H7: Habitual use of digital educational technologies positively affects science teachers' intention to adopt GSBL.

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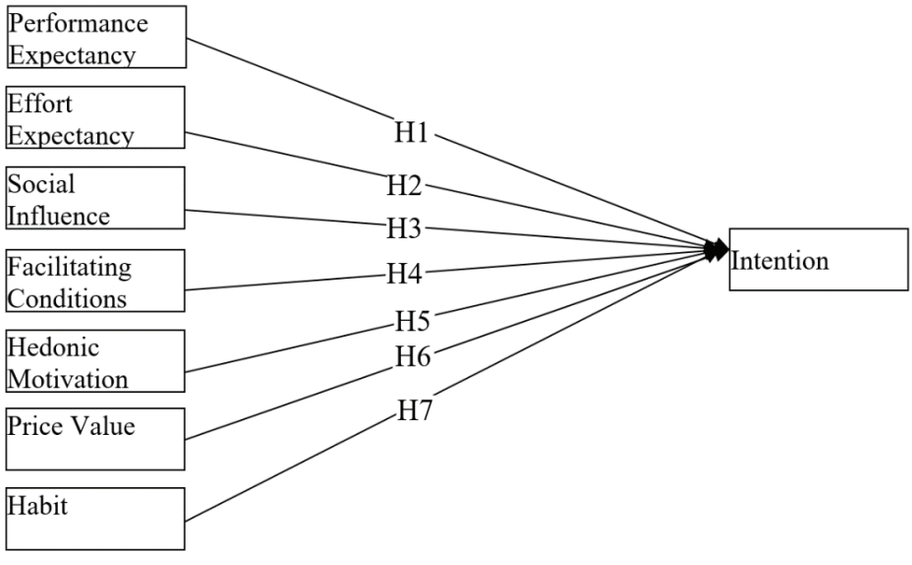
The proposed research model is presented in Figure 1.

Figure 1
The Conceptual Research Model



Research Methodology

General Background

This study adopted a quantitative research approach employing a cross-sectional survey design to examine in-service science teachers' intentions to adopt GSBL. A survey-based methodology was considered appropriate given the study's aim to examine latent psychological and contextual factors derived from the UTAUT2 framework and to test theoretically hypothesized relationships among these constructs.

A cross-sectional research time frame was adopted because the study sought to capture teachers' adoption intentions as they exist at a specific point in time, reflecting prevailing perceptions, beliefs, and contextual conditions rather than changes or developments over time. This approach is consistent with prior technology acceptance research, which commonly employs cross-sectional designs to address determinants of behavioral intention (Hair et al., 2022; Venkatesh et al., 2012).

The research was grounded in a post-positivist paradigm, which assumes that social phenomena can be systematically addressed through empirical observation while acknowledging that knowledge claims are probabilistic and theory-laden (Creswell & Creswell, 2018; Phillips & Burbules, 2000). Within this paradigm, teachers' adoption intentions are conceptualized as latent constructs that can be measured indirectly through observable indicators and statistically modeled to explain underlying relationships.

Covariance-based structural equation modeling (CB-SEM) was employed as the primary analytical technique because it enables rigorous theory testing through the simultaneous assessment of measurement validity and structural relationships among latent variables (Kline, 2016; Hair et al., 2022). Overall, the methodological design was structured to ensure rigor, transparency, and replicability, thereby providing a solid empirical basis for the study's conclusions.

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Sample

The target population of the study consisted of in-service science teachers employed at middle and secondary school levels within the national education system. Participants were enrolled through a nationwide in-service professional development program designed to support teachers' integration of innovative educational technologies, with particular emphasis on GSBL in science education. This participant selection approach was deliberately selected because it provided access to a professionally relevant and geographically diverse group of practicing teachers for whom GSBL adoption is pedagogically meaningful, thereby ensuring close alignment between the study's purpose and the participant group.

A total of 800 in-service science teachers participated in the study (see Table 1). The sampling strategy can be characterized as voluntary, non-probabilistic, and purposive, as participation was limited to teachers actively engaged in technology-focused professional development. This approach was considered appropriate given the study's aim to examine adoption intentions among potential users of GSBL, rather than the general teacher population. While this strategy may involve some degree of self-selection, it is consistent with prior technology adoption research and is explicitly acknowledged when interpreting the findings.

With respect to school level, 58% of participants were taught at the middle school level and 42% at the secondary school level. The gender distribution was relatively balanced, with 54% female and 46% male teachers, closely reflecting the national gender composition of the teaching workforce. Participants also represented a broad range of professional experience: 24% had 5 years or less teaching experience, 37% had between 6 and 15 years, and 39% had more than 15 years of experience.

In terms of school context, 63% of participants were employed in urban or suburban schools, whereas 37% worked in rural or semi-rural settings. Additionally, 68% of teachers reported having regular access to digital educational technologies (e.g., interactive whiteboards, computer laboratories, or tablet-supported classrooms), while 32% indicated limited or inconsistent access, highlighting meaningful variability in contextual facilitating conditions relevant to GSBL adoption.

Participation was entirely voluntary, and all respondents provided informed consent prior to data collection. To ensure data quality, questionnaires containing substantial missing data or response patterns indicative of inattentive responding were excluded from the final dataset.

The final sample size of 800 participants was considered methodologically adequate and reliable for the purposes of this study. Sample size adequacy was evaluated with reference to established guidelines for covariance-based structural equation modeling (CB-SEM), which requires relatively large samples to ensure stable parameter estimation, accurate assessment of model fit, and sufficient statistical power, particularly in models involving multiple latent constructs.

Methodological authorities commonly recommend a minimum of 200 cases for CB-SEM, with larger samples preferred as model complexity increases. Given the complexity of the adapted UTAUT2 model tested in this study, the achieved sample size substantially exceeds recommended thresholds, providing strong statistical power for hypothesis testing, robust estimation of structural paths, and reliable evaluation of global model fit indices. Accordingly, the sample size can be considered sufficient to support valid and reliable conclusions regarding the determinants of GSBL adoption among in-service science teachers.

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Table 1
Demographic Characteristics of the Participants

Characteristic	Category	*n*	%
Gender	Female	432	54.0
	Male	368	46.0
School Level	Middle School	464	58.0
	Secondary School	336	42.0
Teaching Experience	≤ 5 years	192	24.0
	6–15 years	296	37.0
	> 15 years	312	39.0
School Context	Urban / Suburban	504	63.0
	Rural / Semi-rural	296	37.0
Access to Digital Technologies	Regular access	544	68.0
	Limited / inconsistent access	256	32.0

Note. Percentages may not total 100 due to rounding.

Instrument and Procedures

Data were collected using a structured self-administered questionnaire adapted from validated UTAUT2 instruments originally developed by Venkatesh et al. (2012) and subsequently employed in teacher and educational technology adoption studies. As the original UTAUT2 items were developed in English, a rigorous translation and back-translation procedure was employed following Brislin's (1970) guidelines to ensure semantic and conceptual equivalence in Turkish. Discrepancies between the original and back-translated versions were resolved through expert consensus involving specialists in science education and educational technology.

The questionnaire consisted of two sections. The first section gathered demographic information, including gender, years of teaching experience, school level, and general frequency of digital technology use in teaching. The second section measured the UTAUT2 constructs, including performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value (conceptualized in this study as perceived educational return on investment), habit (defined as routine engagement with digital educational technologies), and behavioral intention, using items adapted to the science education context.

21 items were measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Although seven-point scales are frequently used in technology acceptance research, a five-point scale was selected to reduce cognitive load and response fatigue, given the length of the instrument and the professional constraints of the participants.

To support construct validity and ensure a shared understanding of key terms, participants attended a brief, neutral standardization briefing prior to survey administration. This briefing was limited to operational definitions distinguishing GSBL from general educational technology and did not include evaluative language, persuasive content, or demonstrations intended to promote adoption. Accordingly, the study captures teachers' behavioral intentions within the context of professional development while minimizing potential priming effects.

Prior to the main data collection, a pilot study was conducted with a group of in-service science teachers (n = 145) to evaluate the clarity, relevance, and contextual appropriateness of the adapted questionnaire items. The pilot participants were selected to reflect variability

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in teaching experience and school level, ensuring that the instrument was comprehensible across different professional profiles. The pilot study served multiple purposes: (a) to assess the linguistic clarity of the translated items, (b) to examine the suitability of the items for the science education context, and (c) to identify potential issues related to survey length and respondent burden. Participants were invited to provide written feedback on item wording, ambiguity, and perceived redundancy. Based on the pilot feedback, minor revisions were made to several items, primarily involving simplification of phrasing and alignment with terminology commonly used in science teaching practice. No items were removed or added at this stage, as the pilot results indicated satisfactory content coverage and construct representation. Preliminary reliability analysis conducted on the pilot data yielded Cronbach's alpha values exceeding .70 for all constructs, suggesting acceptable internal consistency prior to the main study. In addition, the average completion time was monitored during the pilot phase and was found to be approximately 20–25 minutes, which was deemed appropriate given the professional constraints of the target population. The finalized questionnaire was subsequently administered electronically to the full sample. Responses were collected anonymously to encourage honest reporting and to reduce potential social desirability bias.

Table 2 presents the measurement items used in the study along with descriptive statistics and reliability and validity indices.

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Table 2

Measurement Items, Descriptive Statistics, and Reliability Indices

Construct / Item	*M*	*SD*	Factor loading	Cronbach's α	AVE	CR
Performance Expectancy (PE)				.89	.68	.91
PE1: Using GSBL enhances students' understanding of science concepts.	3.87	.81	.82			
PE2: GSBL improves the effectiveness of my science teaching.	3.79	.84	.85			
PE3: GSBL supports inquiry-based learning in science.	3.92	.78	.83			
Effort Expectancy (EE)				.87	.64	.90
EE1: Learning to use GSBL is easy for me.	3.61	.88	.81			
EE2: I find GSBL easy to integrate into my science lessons.	3.55	.91	.79			
EE3: It is easy for me to become skillful at using GSBL.	3.68	.86	.83			
Social Influence (SI)				.85	.66	.89
SI1: School administrators encourage me to use GSBL.	3.42	.97	.82			
SI2: Colleagues whose opinions I value support the use of GSBL.	3.58	.89	.84			
Facilitating Conditions (FC)				.88	.69	.91
FC1: I have access to the necessary resources to use GSBL.	3.71	.83	.85			
FC2: I receive adequate technical support for GSBL.	3.46	.92	.81			
FC3: My school infrastructure supports GSBL use.	3.62	.87	.84			
Hedonic Motivation (HM)				.90	.72	.93
HM1: I enjoy using GSBL in science teaching.	3.88	.79	.86			
HM2: Using GSBL makes teaching science more enjoyable.	3.94	.76	.88			
HM3: I find GSBL interesting to use.	3.90	.80	.84			
Price Value (PV – Educational ROI)				.86	.63	.89
PV1: The educational benefits of GSBL justify the time required.	3.67	.85	.81			
PV2: GSBL is worth the effort invested for student learning.	3.74	.82	.83			
Habit (HT – Digital Routine)				.84	.61	.88
HT1: Using digital technologies is a natural part of my teaching routine.	3.81	.84	.79			
HT2: I regularly use digital tools in my science lessons.	3.76	.86	.82			
Behavioral Intention (BI)				.92	.74	.94
BI1: I intend to use GSBL in my future science teaching.	3.89	.77	.87			
BI2: I plan to integrate GSBL into my science lessons.	3.85	.79	.88			
BI3: I will make an effort to use GSBL regularly.	3.91	.75	.86			

Data Analysis

Data analysis proceeded in a two-step approach, beginning with an assessment of the data's distributional properties and measurement quality, followed by testing of the hypothesized structural relationships. In the first step, descriptive statistics (means, standard deviations, skewness, and kurtosis) were computed to examine the distributional properties of

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the observed variables and to ensure compliance with assumptions of multivariate normality. No severe deviations from normality were observed, supporting the use of maximum likelihood estimation.

The measurement model was subsequently evaluated through confirmatory factor analysis (CFA). Standardized factor loadings were examined to assess indicator reliability, with values exceeding the recommended threshold of .60, indicating that all items adequately represented their intended latent constructs. Internal consistency reliability was assessed using both Cronbach's alpha and composite reliability (CR), with values above .70 for all constructs, demonstrating satisfactory reliability.

Convergent validity was evaluated by examining average variance extracted (AVE) values. All constructs exhibited AVE values greater than the .50 criterion, indicating that a substantial proportion of variance was captured by the latent construct relative to measurement error. Discriminant validity was assessed by comparing the square root of each construct's AVE with the inter-construct correlations, in accordance with the Fornell–Larcker criterion. The results confirmed that each construct shared more variance with its indicators than with other constructs, supporting discriminant validity.

Given the cross-sectional and self-reported nature of the data, common method bias was explicitly examined using Harman's single-factor test. The unrotated factor solution revealed that no single factor accounted for more than 50% of the total variance, suggesting that common method bias was unlikely to substantially influence the results.

Following validation of the measurement model, the structural model was tested using covariance-based SEM to examine the hypothesized relationships among UTAUT2 constructs. Overall model fit was evaluated using multiple goodness-of-fit indices, including the chi-square to degrees of freedom ratio (χ^2/df), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). The obtained fit indices met or exceeded commonly accepted thresholds (χ^2/df < 3, CFI and TLI ≥ .90, RMSEA ≤ .08, SRMR ≤ .08), indicating an acceptable to good model fit.

Finally, standardized path coefficients, corresponding standard errors, and significance levels were examined to test the proposed hypotheses, while the results of the measurement model including inter-construct correlations, square roots of the average variance extracted (√AVE), and descriptive statistics are summarized in Table 3. All analyses were conducted using IBM SPSS Statistics 26.0 and IBM SPSS AMOS 26.0, following established best practices for covariance-based structural equation modeling (CB-SEM).

Table 3
Discriminant Validity, Correlations, and Descriptive Statistics

Construct	1	2	3	4	5	6	7	8	√AVE	*M*	*SD*
1. Performance Expectancy	–								.82	3.86	.81
2. Effort Expectancy	.54	–							.80	3.61	.88
3. Social Influence	.48	.42	–						.81	3.50	.93
4. Facilitating Conditions	.51	.46	.49	–					.83	3.60	.87
5. Hedonic Motivation	.58	.44	.41	.47	–				.85	3.91	.78
6. Price Value	.53	.40	.38	.42	.55	–			.79	3.71	.84
7. Habit	.46	.39	.36	.41	.43	.44	–		.78	3.79	.85
8. Behavioral Intention	.61	.52	.49	.50	.58	.54	.51	–	.86	3.88	.77

Note. Off-diagonal elements represent inter-construct correlations. The square root of the average variance extracted (√AVE) appears in the rightmost column. Discriminant validity is supported because the √AVE for each construct exceeds its correlations with other constructs. *M* = mean; *SD* = standard deviation.

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Research Results

Structural Model Analysis

Following the validation of the measurement model, the structural model was evaluated using covariance-based structural equation modeling with maximum likelihood estimation. The goodness-of-fit indices indicated that the proposed UTAUT2 model demonstrated an acceptable to good fit with the data. The chi-square to degrees of freedom ratio (χ^2/df) was below recommended thresholds, and both absolute and incremental fit indices met established criteria. Overall, the model explained a substantial proportion of variance in science teachers' behavioral intention to adopt GSBL.

The detailed results of the structural model fit indices are presented in Table 4.

Table 4
Goodness-of-Fit Indices for the Structural Model

Fit indices	Suggested value	Model fit indices
χ^2	–	465.12
df	–	162
χ^2/df	≤ 2 to ≤ 5	2.87
GFI	≥ .90	.91
IFI	≥ .90	.93
TLI	≥ .90	.92
CFI	≥ .90	.93
RMSEA	≤ .08	.04
SRMR	≤ .08	.04
R^2 (Behavioral Intention)	–	.54

Note. Suggested cutoff values are based on Hair et al. (2018), Hu and Bentler (1999), and Kline (2005). χ^2 = chi-square; df = degrees of freedom; GFI = goodness-of-fit index; IFI = incremental fit index; TLI = Tucker–Lewis index; CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.

Hypothesis Testing and Structural Path Results

The hypothesized relationships of the adapted UTAUT2 model were examined using covariance-based structural equation modeling with maximum likelihood estimation. Hypothesis testing was conducted by evaluating standardized regression weights (β), standard errors (S.E.), and corresponding *t*-values. The statistical significance and magnitude of each structural path were assessed to determine the relative influence of UTAUT2 determinants on science teachers' behavioral intention to adopt GSBL.

The results indicate that all seven UTAUT2 constructs exerted statistically significant effects on behavioral intention, although the strength of these effects varied. Performance expectancy emerged as the strongest predictor of behavioral intention (β = .28, t = 6.83), suggesting that science teachers are more likely to adopt GSBL when they perceive clear educational benefits for enhancing inquiry, conceptual understanding, and student engagement. Hedonic motivation also demonstrated a strong positive influence (β = .26, t = 6.67), indicating that intrinsic enjoyment and professional satisfaction associated with GSBL use play a substantial role in adoption decisions.

Facilitating conditions had a moderate but significant effect on behavioral intention (β = .19, t = 5.59), highlighting the importance of institutional infrastructure, technical support, and access to digital resources in enabling GSBL integration. Effort expectancy similarly showed a significant effect (β = .17, t = 4.72), suggesting that perceived ease of learning and implementation remains a relevant, though secondary, consideration for science teachers.

Social influence exhibited a positive and statistically significant, yet comparatively weaker, effect on behavioral intention (β = .14, t = 4.38), reflecting the role of school leadership expectations and peer norms in shaping teachers' technology adoption behaviors. Price value, conceptualized as perceived educational return on investment, also significantly predicted behavioral intention (β = .16, t = 4.85), indicating that teachers evaluate GSBL adoption by weighing anticipated pedagogical gains against the time and effort required for implementation.

Finally, habit, defined as routine engagement with digital educational technologies, had a modest but significant effect on behavioral intention (β = .13, t = 4.33). This finding suggests that teachers with established digital teaching routines are more inclined to incorporate GSBL into their educational practices, even when the technology itself is relatively novel.

Collectively, the seven UTAUT2 constructs explained 54% of the variance in behavioral intention, demonstrating strong explanatory power of the adapted model in the context of in-service science teachers. A summary of the hypothesis testing results is presented in Table 5 and Figure 2.

Table 5

Structural Path Estimates and Hypothesis Testing Results

Hypothesis	Structural path	β	*t*-value	Result
H1	Performance Expectancy → Behavioral Intention	.28	6.83	Supported
H2	Effort Expectancy → Behavioral Intention	.17	4.72	Supported
H3	Social Influence → Behavioral Intention	.14	4.38	Supported
H4	Facilitating Conditions → Behavioral Intention	.19	5.59	Supported
H5	Hedonic Motivation → Behavioral Intention	.26	6.67	Supported
H6	Price Value → Behavioral Intention	.16	4.85	Supported
H7	Habit → Behavioral Intention	.13	4.33	Supported

Note. All coefficients are standardized regression weights. All t-values are significant at $p < .001$.

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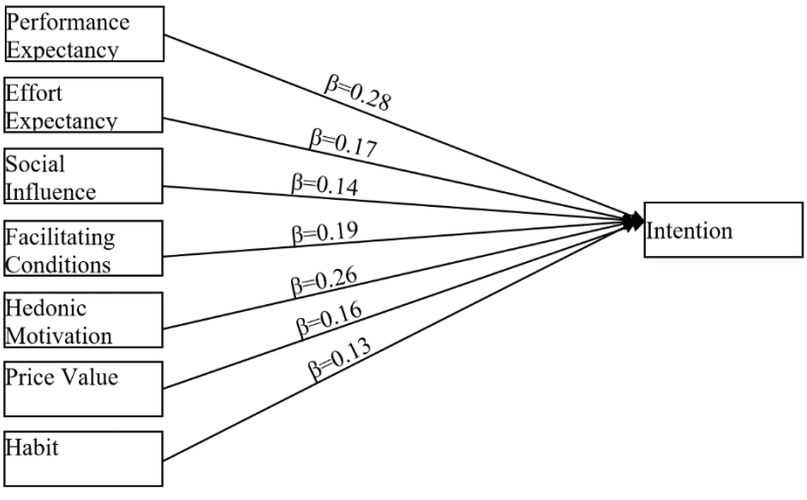
Figure 2
Results of the structural equation model for science teachers' adoption of GSBL.



Discussion

The present study examined the factors shaping in-service science teachers' intention to adopt GSBL through a contextually adapted UTAUT2 framework. Overall, the model accounted for 54% of the variance in behavioral intention, indicating strong explanatory power in a school-based teaching context. This level of explained variance is broadly consistent with, and in some cases higher than, that reported in international teacher-focused technology acceptance studies (Cao et al., 2025; Khoshtaria et al., 2026; Nikolopoulou et al., 2021), supporting the position that UTAUT2 can be informative in education when constructs are appropriately contextualized.

Performance expectancy emerged as the strongest predictor of behavioral intention. A plausible explanation is that science teachers are likely to prioritize approaches that support core disciplinary goals such as inquiry, modelling, and conceptual understanding of abstract or unobservable phenomena. In science education, where learning often depends on visualization and dynamic representation (National Research Council, 2012), teachers may evaluate GSBL chiefly in terms of perceived pedagogical contribution rather than novelty or external pressure. This pattern is consistent with international findings showing performance expectancy as a dominant determinant of teachers' technology acceptance (Cao et al., 2025; Khoshtaria et al., 2026; Nikolopoulou et al., 2021). The present study extends these studies by interpreting performance expectancy as reflecting pedagogical–content alignment, which resonates with the logic of technological pedagogical content knowledge (Mishra & Koehler, 2006).

Hedonic motivation was the second strongest predictor of behavioral intention. One possible reason is that GSBL may enhance teachers' professional satisfaction by making classroom experiences more engaging and by enabling more varied teaching approaches, which can be particularly valuable in a cognitively demanding subject area. This result is broadly consistent with motivational perspectives emphasizing the role of intrinsic satisfaction in sustaining professional behaviors (Deci & Ryan, 2000). At the same time, prior research has reported mixed results regarding hedonic motivation in teacher adoption models (Ateş & Kölemen, 2025a), suggesting that its influence may vary by subject domain, tool type, or contextual conditions. In comparison with student-centered gamification literature, where hedonic motivation is often prominent (Luarn et al., 2025), the present findings clarify that enjoyment and professional vitality can also be consequential for teachers' adoption intentions.

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Facilitating conditions demonstrated a moderate but significant influence on behavioral intention. A likely explanation is that, even when teachers perceive GSBL as beneficial, adoption remains contingent on access to adequate technological resources and organizational support. This result is consistent with international work indicating that infrastructure, technical support, and school-level enablers shape teachers' willingness and capacity to adopt digital approaches (Du & Liang, 2024; Tseng et al., 2022). The present findings support this line of evidence by showing that enabling conditions remain consequential even when other determinants (e.g., perceived value and motivation) are strong, thereby confirming that adoption decisions are embedded within organizational realities rather than being purely individual choices.

Effort expectancy and social influence were statistically significant but comparatively weaker predictors. One possible reason is that baseline digital competence among teachers may reduce the salience of ease-of-use concerns, while adoption decisions may rely more heavily on perceived pedagogical contribution than on colleagues' or administrators' expectations. This pattern aligns with findings from some teacher-focused acceptance studies where effort expectancy and social influence play secondary roles once teachers are familiar with digital tools (Nikolopoulou et al., 2021; Tseng et al., 2022). However, this finding may differ from contexts where technology use is mandated or where peer norms are stronger, suggesting that the influence of social influence may be more context-dependent than universal.

The results provide clear support for the reinterpretation of price value as perceived educational return on investment. A plausible explanation is that teachers evaluate GSBL not as consumers weighing monetary cost, but as professionals balancing time, preparation effort, and classroom disruption against perceived pedagogical gains. This interpretation is consistent with arguments that teachers' technology decisions are shaped by perceived payoff relative to workload constraints rather than financial expenditure (Scherer et al., 2019; Teo, 2011). Importantly, earlier school-based applications of UTAUT2 have often reported weak or inconsistent effects for price value (Du & Liang, 2024; Tseng et al., 2022). The present findings therefore differ from those studies in form but help clarify them theoretically: when the construct is conceptually aligned with teachers' professional evaluations, it becomes empirically meaningful.

Finally, habit, conceptualized as general digital teaching routine, had a modest but significant effect on behavioral intention. One possible explanation is that teachers with established digital routines experience lower uncertainty and fewer barriers when adopting new digital approaches. Prior research has highlighted conceptual challenges in applying habit to teachers when it is defined as repeated use of a specific technology (Ateş & Garzón, 2022; Ifenthaler & Schweinbenz, 2013). In contrast, the present study's findings support treating habit as contextual readiness rather than post-adoption continuation, clarifying how habit can be relevant even in adoption-focused research.

Limitations and Suggestions for Future Studies

Despite the theoretical and methodological rigor of the present study, several limitations should be acknowledged, which also indicate directions for future research. First, the study employed a cross-sectional survey design, which restricts the ability to draw causal inferences regarding the relationships among the UTAUT2 constructs. Although the proposed model was theoretically grounded and empirically supported, future studies adopting longitudinal or experimental designs would be valuable for examining how teachers' adoption intentions translate into actual classroom use over time, particularly as digital routines and organizational conditions evolve.

Second, the study relied exclusively on self-reported measures, which may be subject to common method bias and social desirability effects, despite the procedural and statistical

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controls implemented. Future research could strengthen validity by incorporating additional data sources, such as system log data, classroom observations, or teaching artefacts, to triangulate teachers' reported intentions with observed classroom practices.

Third, although the sample size was large and geographically diverse, participants were recruited through a national professional development program focused on educational technologies. As a result, the sample may overrepresent teachers who are relatively open to innovation. Future studies could examine more heterogeneous teacher populations, including those with limited prior exposure to digital technologies, to explore whether adoption mechanisms vary across levels of technological readiness.

Fourth, the construct of habit was conceptualized as general digital teaching routine rather than prior or continued use of gamification or simulation-based learning specifically. While this adaptation was theoretically appropriate within a pre-adoption context, future longitudinal research could examine how GSBL-specific habits develop over time and how they relate to continuation intention and sustained classroom use once these practices become more institutionalized. Such work would further refine understanding of the temporal dynamics of habit formation in educational technology adoption.

Finally, this study focused exclusively on science education, where the epistemic demands of inquiry, visualization, and experimentation are particularly salient. While this domain-specific focus represents a strength, future research should examine whether the adapted UTAUT2 framework, particularly the interpretation of price value as perceived educational return on investment, extends to other subject areas such as mathematics, social sciences, or language education. Comparative, cross-disciplinary studies would contribute to the development of more nuanced and discipline-sensitive models of technology acceptance in education.

Conclusion and Implications

This study contributes to the literature on educational technology adoption by offering a discipline-sensitive explanation of how and why in-service science teachers decide to integrate GSBL. Situated within the broader challenge of aligning educational technologies with pedagogical practice, the findings demonstrate that teachers' adoption intentions can be systematically explained through a coherent combination of perceived educational value, affective engagement, and contextual support. Collectively, these factors accounted for a substantial proportion of variance in behavioral intention, underscoring that technology adoption in science education is a pedagogically situated and professionally meaningful process rather than a novelty-driven or externally imposed decision.

At a more general level, the results suggest that science teachers' adoption of GSBL is shaped by professional judgments regarding pedagogical alignment, educational payoff, and the conditions that enable sustainable classroom implementation. Rather than being driven primarily by ease of use or social pressure, adoption decisions reflect teachers' evaluations of how well digital technologies support epistemic goals in science teaching and contribute to meaningful learning experiences.

From a theoretical standpoint, this study demonstrates that the applicability of the UTAUT2 framework in educational settings depends on contextual and conceptual refinement. In particular, conceptualizing price value as perceived educational return on investment and habit as routine engagement with digital educational practices provides greater explanatory clarity for understanding teachers' technology adoption behavior. By situating technology acceptance within disciplinary pedagogy and established professional routines, the findings underscore the importance of adapting general technology acceptance models to reflect the realities of teaching practice.

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The findings also carry important implications for practice. Professional development initiatives should prioritize demonstrating the pedagogical relevance of GSBL for inquiry-based science education rather than focusing solely on technical functionality. Experiential and design-oriented learning opportunities may further enhance teachers' professional engagement and support sustained adoption. At the school and policy levels, establishing stable digital teaching routines and providing curriculum-aligned GSBL resources can reduce cognitive and educational costs, thereby strengthening perceived educational return on investment and facilitating the integration of GSBL as an embedded educational practice.

In sum, this study demonstrates that science teachers' adoption of GSBL is best understood as a pedagogically grounded, affectively informed, and contextually enabled process. By refining UTAUT2 to reflect the professional realities of science teaching, the study advances both theory and practice and contributes to a more nuanced understanding of educational technology adoption in contemporary classrooms.

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TEACHERS' READINESS TO INTEGRATE DIGITAL TECHNOLOGY INTO THE TEACHING PROCESS

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Abstract

In recent years, the rapid development of digital technology has led to profound changes in the design and materialization of the educational process. The integration of digital technology into teaching and learning activities is no longer just a methodological option, but an essential skill for today's teachers. However, the level of teacher training varies considerably, influenced by several factors, including basic technical skills, attitudes toward technology, and experience with digital applications and platforms. In this context, a systematic analysis is needed of how teachers perceive and express their digital competences, as well as how those are reflected in their teaching practice. The purpose of the research was to assess the teachers' readiness to introduce and integrate digital technology into the teaching process. To do this, a bidimensional model has been developed that features two dimensions: digital literacy and experience in using digital technology. The model has been tested on a sample of 579 Romanian teachers, and the results show a relatively low level of digital literacy and experience with digital technology. The group analysis revealed significant differences between teachers from urban and rural areas.
Keywords: *digital literacy, digital technology, exploratory research, teaching process*

Introduction

The actual education is undergoing a period of profound reconfiguration and transformation, in line with the societal evolution and demands of a labor market dominated by digitization. Digital native students have different needs, expectations, learning rhythms, and methods, which require the adaptation of both content and teaching strategies. In this context, technology is no longer just an auxiliary tool but becomes a learning environment in itself, in which the teacher acts as a mediator of knowledge, a facilitator of learning, a creator of resources, and a designer of learning experiences. The intelligent integration of digital resources, the development of transversal competences, and the promotion of autonomous learning thus become essential benchmarks for relevant and sustainable education.

In Romania, digitization in education has become a strategic priority, both in public policy documents and in the modernization of school infrastructure. In this respect, between 2021 and 2027, the Ministry of Education implements the National Strategy for the Digitalization of Education in Romania - SMART-Edu (Modern, Accessible School, based on Digital Resources and Technologies) (https://www.smart.edu.ro/), which includes several areas of action: developing students' digital skills, developing teachers' digital competences, improving digital infrastructure and connectivity, disseminating open educational resources, improving cybersecurity etc. to build an educational ecosystem capable of responding to the new challenges of the digital world.

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Under the National Recovery and Resilience Plan, Component 15 - Education / Reform 5, the Ministry of Education allocates funds to equip schools with digital equipment and to train teachers to develop digital skills through the training program *Digital Pedagogy and Innovation in the Contemporary School*. Romania is thus aligning with European guidelines on modernizing education through digitization, promoting the development of digital skills, equitable access to technological resources, and the integration of innovative teaching practices that harness the potential of new technologies.

Digital pedagogy involves much more than simply using digital tools in teaching. The integration and strategic use of technology requires a deep understanding of how technology can support active, collaborative, and differentiated learning, transforming digital tools from simple technical means into catalysts for educational progress. Currently, teachers use digital technology in the classroom, but not all of them manage to optimize the teaching and learning process fully. Also, the degree of familiarity with digital technology, as well as its actual use, varies, and there are few studies that measure this in the Romanian context.

Taking into account the above-mentioned considerations aligned with the recent policies of the Romanian Ministry of Education, this study aimed to explore the teachers' readiness for introducing and integrating digital technology into the teaching process. This research was carried out through the "*Digital Innovation in Pre-university Education*" project (https://www.digiped.ro/), managed by Valahia University of Târgoviște, Romania. In this project, the training sessions have been organized into 6 units, with teachers interacting with their trainers both in synchronous and asynchronous modes. The asynchronous channel was mediated through the *Moodle* platform, offering teachers the opportunity to access learning materials, interact with teachers and colleagues, and receive specific tasks (Gorghiu et al., 2009).

Related Work

The integration of digital technologies in education has considerable potential to optimize teaching and learning by facilitating student engagement, collaboration, autonomy, and learning self-regulation. Digital tools can increase students' interest and motivation to learn, allowing, at the same time, the personalization of each student's educational path (Zou et al., 2025). However, their effectiveness depends on coherent pedagogical integration, the level of digital competence of teachers and students, and rigorous planning. More challenges, such as distractions, cognitive overload, or inequalities in access, must be carefully managed so that digitization brings real benefits to all students (Forsström et al., 2025).

Digital competence encompasses a set of interdependent skills for accessing, exploring, understanding, evaluating, producing, and responsibly disseminating information using digital technologies (Forsström et al., 2025). Yazon et al. (2019) considered that a central element is information manipulation, i.e., the ability to evaluate, organize, and apply digital data in a relevant and functional way. Zou et al. (2025) stated that nowadays students interact with an increasingly complex digital landscape; in this context, schools must develop the skills they need to critically evaluate information, collaborate, and create content in the digital environment.

Research on the integration of technology in education has generated several models and theories to assess teachers' digital competence. Mohebi (2021) analyzed several models frequently used in literature to explain the integration of interactive technologies in teaching: Teacher Thoughts and Action Process (TTAP), Theory of Planned Behaviour (TPB), Expectancy-Value Theory of Achievement Motivation (EVTAM), Substitution Augmentation Modification Redefinition (SAMR), Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), and Technological Pedagogical and Content Knowledge (TPACK).

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The study of Mohebi (2021) argued that for the effectiveness of technology, teachers must be prepared not only technically but also pedagogically. Therefore, the training process needs to target both the development of technological skills (using tools) and the ability to pedagogically integrate technology into teaching, lesson planning, and assessment.

In line with Mohebi (2021), Fernández-Sánchez et al. (2022) found that although many teachers have positive attitudes toward technology, they tend to focus more on the tools used and less on the pedagogical value they bring. The study emphasized that the integration of technology must be driven by pedagogical objectives, not just by the pressure to adopt modern gadgets because others are doing it. Thus, there is a need for clearly defined pedagogical models to guide the integration of technology into the teaching process.

Research conducted by Aleksieva et al. (2025) analyzed how primary school teachers integrate technology into their daily work, seeking to compare stated intentions with actual classroom practices. Although teachers mentioned that they intended to promote student-centered approaches, encourage collaboration, and develop digital skills, direct observations illustrated that such objectives were only partially introduced into practice. The results highlight a consistent discrepancy between teachers' aspirations for adopting innovative approaches and the realities of their implementation in the classroom, where there remains a significant reliance on familiar and perceived safe technological tools.

Consoli et al. (2025) emphasize that integrating technology into the teaching process should not focus exclusively on the frequency of its use in teaching activities, but also on the quality of its incorporation into instructional practice. Thus, they developed and validated a tool (TIQS) to measure students' perceptions of how technology supports four dimensions of teaching quality: learning support, classroom management, individualized teaching, and cognitive activation. The results support the generic theory of teaching quality (Three Basic Dimensions, TBD - Praetorius et al., 2018) and suggest that it is necessary to explore the interactions between those dimensions to fully understand the effects of technological integration.

Raave et al. (2024) explored how and why teachers in Estonian schools integrate digital technology into their teaching and learning activities; they identified six teacher profiles based on how they integrate technology and their motivations: motivating facilitators, depth facilitators, efficiency engineers, engaging innovators, depth divers, and motivating traditionalists.

A recent study of Li (2025) explored the digital divide with respect to technology integration in Chinese primary schools and found significant differences between urban and rural areas. Since rural teachers showed lower proficiency and attitude, suggesting the effort should be made for an equitable policy making. A similar digital divide has been analyzed by Ahiaku et al. (2025), which was mainly due to the poor infrastructure of schools in rural areas, leading to a disconnection from the Internet.

Regarding the level of teachers' readiness to integrate digital technologies into the educational process, research conducted by Warsi & Rani (2024) and Laius & Orgusaar (2025) indicates that teachers generally recognize the role and positive impact of digital technologies on the effectiveness of teaching and on student outcomes. However, the effective integration of technology into teaching is often limited by a number of structural and professional factors, such as insufficient technological infrastructure, a lack of practical training opportunities in digital skills, and limited access to relevant professional development programs. In this context, the authors emphasize the need to strengthen teachers' digital competencies through systematic continuing education programs, supported by institutional investments in technological resources and educational policies that support the effective integration of digital technologies into contemporary teaching practices.

Two research questions guided this study:

RQ1: What is the level of teachers' readiness to introduce and integrate digital technology into the teaching process?

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RQ2: Are there differences as regards digital literacy and experience with digital technologies between teachers from urban and rural areas?

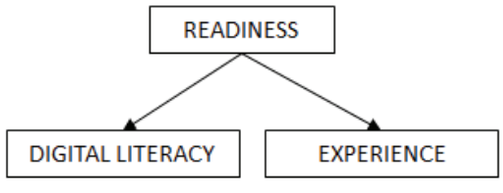
To answer these questions, a bidimensional model has been proposed that features two dimensions: digital literacy and teachers' experience of integrating digital applications into the teaching process. The model was tested on a sample of teachers enrolled in the above training program.

Research Methodology

Model and Operationalization

The teachers' readiness for integrating digital technologies into the teaching process (TR) has been conceptualized as a second-order factor that loads on two dimensions (first-order constructs): experience in using the digital technology (DL) and practice of integrating the digital technology into the teaching process (EXP). The research model is presented in Figure 1.

Figure 1
Research Model



The first dimension refers to basic knowledge, such as familiarity with technology and ease of use. The second refers to the experience of using technology in the teaching process, more specifically, the integration of various digital instruments and tools in teaching and assessment.

The constructs and measures are presented in Table 1.

Table 1
Questionnaire

Item	Question
DL1	How familiar are you with digital tools?
DL2	How easy do you find the integration of technology in the teaching process?
DL3	How easy do you find learning about new digital tools on your own?
EXP1	How often do you use educational platforms in your teaching?
EXP2	How often do you integrate digital assessments into the learning process?
EXP3	To what extent do you experiment with new technologies or applications in teaching?

Procedure and Sample

To collect data, the questionnaire was administered in April-October 2025 to teachers enrolled in the teachers' training program. Participant teachers were asked to answer questions concerning their skills and experience related to the use of digital technology on a 5-point

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Likert scale. A total of 579 questionnaires have been received. After checking the responses for completeness, 138 were eliminated, resulting in a working sample of 441 observations.

Most of the participants (95%) are women (22 M/ 419 F). Regarding school experience, 71 have less than 8 years, 73 between 8 and 15 years, 187 between 16 and 25 years, and 110 over 25 years. A total of 261 teachers are from schools in the urban area, while 180 are from schools in the rural area.

Ethical considerations were respected throughout the research process. Participation was voluntary and based on informed consent. Teachers were informed about the purpose of the study, the anonymous nature of the questionnaire, and their right to withdraw at any time without repercussions. No personally identifiable information was collected, and all responses were treated confidentially. The data was stored securely and used exclusively for academic research purposes, in accordance with current data protection regulations.

Data Analysis

Unidimensionality of first-order constructs has been assessed by examining factor loadings. Convergent validity has been assessed according to the recommended thresholds in the literature (Fornell & Larcker, 1981; Hair et al., 2006), specifically in terms of loading magnitude, construct reliability (CR), and average variance extracted (AVE). Discriminant validity is less relevant here since the dimensions are expected to be highly correlated (Koufteros et al., 2009).

The model fit with the data has been assessed by using the following goodness of fit (GOF) indices, as recommended by Hair et al., 2006: chi-square (χ^2), degrees of freedom (*df*), χ^2/df, comparative fit index (*CFI*), non-normed fit index *(NNFI*), the goodness of fit index (*GFI*), root mean square error of approximation (*RMSEA*), and standardized root mean square residual (*SRMR*).

In this study, differences between urban/rural areas were analyzed. An invariance analysis has been carried out to assess whether the latent variables are equivalent across groups (Byrne, 2010; Vandenberg and Lance, 2000). Lack of invariance makes it impossible to state that differences are due to different perceptions and not to different interpretations of the evaluation instrument (Vandenberg and Lance, 2000).

The model was estimated with LISREL 9.3 for Windows (Mels, 2006), using the maximum likelihood estimation method.

Research Results

Model Testing Results

The mean values of digital literacy measures are relatively low, lying in the range 3.46-3.60, a little bit higher than the neutral value, which shows that many teachers are not familiar with digital technology and find it difficult to use. The frequency of using educational platforms and integrating digital assessments in the learning process is around the neutral value, showing that this is not a current practice. The frequency of integrating technology in the teaching process is 3.50, a little bit higher than the latter measures, but still relatively low. The convergent validity, descriptives, and factor loadings are presented in Table 2.

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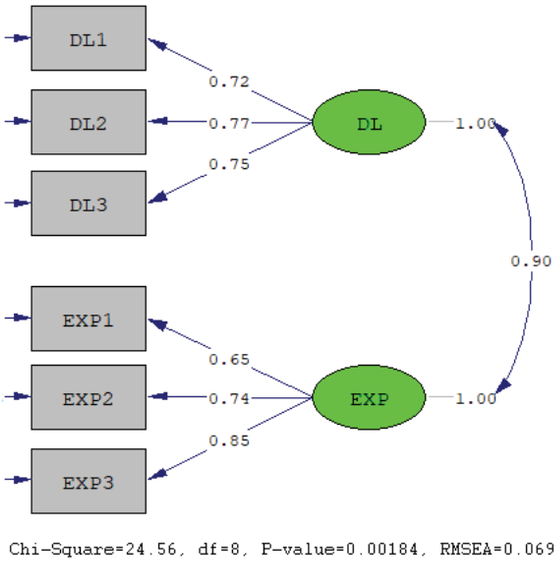
Table 2
Convergent Validity, Descriptives, and Factor Loadings (N = 441)

Construct	CR	AVE	Item	*M*	*SD*	Loading
DL	.791	.558	DL1	3.60	0.79	0.72
			DL2	3.55	0.83	0.77
			DL3	3.46	0.94	0.75
EXP	.783	.564	EXP1	3.10	0.94	0.65
			EXP2	2.98	0.90	0.74
			EXP3	3.50	0.76	0.85

Factor loadings are all over 0.6, showing unidimensionality and a good relationship between the construct and its measures. As presented in Table 2, composite reliability (CR) is greater than 0.7, and the average variance extracted is greater than 0.5, thus showing good convergent validity.

Figure 2
Model Estimation Results (N=441)



The results of model testing are presented in Figure 2. Testing the bidimensional model revealed an acceptable fit of the model with the data: $\chi^2 = 24.56$, $df = 8$, $p = .00184$, $\chi^2 / df = 3.19$, RMSEA = 0.069, CFI = 0.985, NNFI = 0.979, GFI = 0.982, SRMR = 0.0255.

Invariance Analysis

Before starting invariance analysis, the model should be tested for each group. The results presented in Table 3 show a good fit of the model with the data for both urban and rural samples.

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Table 3
Model Estimation Results for the Urban (N=261) and Rural (N=180) Samples

Samples	χ^2	DF	CFI	NNFI	GFI	RMSEA	SRMR
Urban	10.92	8	0.994	0.989	0.982	0.045	0.0268
Rural	15.31	8	0.988	0.977	0.981	0.053	0.0276
Unconstrained	26.33	16	0.994	0.989	0.982	0.054	0.0208

In the first step, a multi-group CFA (MGCFA) has been conducted to check if the scale is invariant across areas. MGCFA is based on testing a hierarchical series of nested models, starting with a baseline (unconstrained) model that fits both samples together, from which a baseline chi-square value is derived. Model testing results showed a good fit of the unconstrained model with the data.

The next step was to test the metric invariance by constraining the loadings to be equivalent. The model comparison in Table 4 shows a nonsignificant chi-square difference ($\Delta\chi^2 = 4.461$, $\Delta DF = 4$, $p = 0.347$), which means that the model has been perceived in the same way in each group.

Testing the scalar invariance was done by constraining the intercepts to be equivalent. The model comparison showed a significant chi-square difference ($\Delta\chi^2 = 13.625$, $\Delta df = 6$, $p = .034$). Therefore, the depreciation of CFI has been examined according to the criterion of Cheung and Rensvold (2002). Since the depreciation is higher than 0.01, the model doesn't have scalar invariance. Nevertheless, the metric invariance enables the analysis of differences between observed variables.

Table 4
Model Comparison

Model	χ^2	*df*	CFI	$\Delta\chi^2$	Δdf	ΔCFI	*p*
unconstraint	26.33	16	0.994				
Metric invariance	30.79	20	0.994	4.462	4	0.000	0.347
Scalar invariance	44.42	26	0.980	13.63	6	-0.014	0.034

Analysis of Group Differences

The mean values of variables in each group are presented in Figure 3. As could be noticed, teachers from the urban area reported much higher digital literacy and experience than teachers from the rural area.

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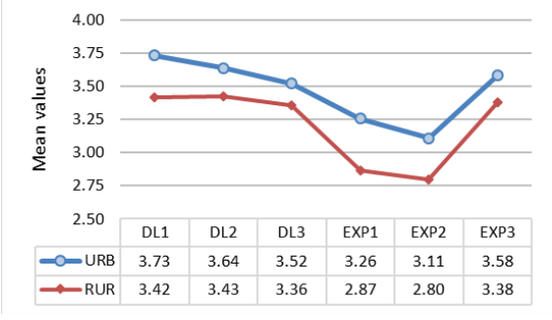
Figure 3
Area Differences



A one-way ANOVA (1, 439, 440) showed that the differences are significant for DL1 (F17.27, $p < .001$), DL2 ($F = 6.96$, $p = .009$), EXP1 ($F = 1\ 9.30$, $p < .001$), EXP2 ($F = 13.06$, $p < .001$), and EXP3 ($F = 7.41$, $p = .007$). The only variable for which the difference is not statistically significant is DL3 (learning about new technologies).

Discussion

This study provides an important contribution by exploring how teachers perceive and express their digital competences, as well as how those competences manifest themselves in daily teaching practice. The results show that the two-factor structure of the model is well supported, highlighting distinct differences and trends across educational settings, and providing a holistic perspective on how technology is currently integrated into Romanian schools.

The two-dimensional model of teacher training for the integration of digital technology into education covered both digital literacy and practical experience in using technological tools. Through this approach, the study provides an understanding of how the level of digital competence influences teaching strategies, openness to innovation, and the ability to adapt to the demands of contemporary education. The results highlight differences between educational environments, but also areas of convergence, thus contributing to a coherent picture of the current state of technology integration in Romanian schools.

With respect to digital literacy, the obtained values indicate that many teachers are not familiar with digital technology and find it difficult to use. The frequency of use of educational platforms and the integration of digital assessments into the learning process is around neutral, which shows that this is not a common practice. The frequency of integrating technology into the teaching process is slightly higher than the latter measures, but still relatively low.

Although teachers have had to use technology in the teaching process during the pandemic, digital literacy means much more than simply using devices in teaching. Digital literacy involves a complex set of skills, attitudes, and practices that enable the conscious, pedagogical, and ethical integration of technology into the educational process. Teachers with developed digital skills understand how technology works and its learning potential; critically select digital resources, assessing their quality, relevance, and credibility; uses digital tools pedagogically, not just technically, i.e., integrates them to improve learning, differentiation, assessment, or collaboration; develops strategies for online communication and collaboration with students, parents, and colleagues; adheres to the principles of digital safety, protecting personal data and promoting responsible behavior in the online environment; creates and adapts digital content, using tools that stimulate critical thinking, creativity, and student autonomy; reflects on their own digital practices, continuously updates their skills, and follows the

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evolution of educational technologies. These competences must be developed through coherent professional development programs, a conclusion that aligns with the results of several studies (Consoli et al., 2025; Mohebi, 2021; Fernández-Sánchez et al., 2022).

The second dimension of the proposed model - the experience of technology integration - involves more than the occasional use of digital tools and refers to how the teacher manages to use technology coherently, relevantly, and intentionally to support learning, in lesson planning, in choosing optimal teaching strategies, in feedback, and evaluation. The mean values of measures are relatively low, proving the relevance of the program. As expected, digital literacy exhibits larger mean values, except for the last item, which shows the teachers' interest in experimenting with new technologies and the motivation to change something in their teaching methods.

Another finding is given by the invariance analysis, which reveals significant differences between teachers from urban and rural areas. In the former case, teachers are more familiar and experienced with integrating digital technologies into the teaching process. This digital divide is a critical issue that has also been highlighted in recent studies (Ahiaku et al., 2025; Li, 2025).

In Romania, urban area teachers generally benefit from better infrastructure, consistent high-speed internet, and more frequent peer-to-peer professional development. In this respect, it is expected that urban area schools (especially in major cities) may develop a *culture of innovation* framework, where digital tools are woven into the curriculum. On the other hand, unfortunately, in many situations, rural teachers still fight with an important level of *technological isolation*. Even if the schools are digitally equipped, a lack of technical support or localized training leads to using technology mainly for administrative tasks rather than transformative teaching.

However, despite the relatively low mean values and significant differences, teachers show a promising level of interest in familiarizing themselves with new technologies. This convergence may reflect a common intrinsic motivation for professional development, awareness of the importance of digital literacy, or the existence of comparable institutional expectations regarding the development of technological skills in both urban and rural schools. It is also important to think about the impact on students' outcomes: if a teacher is not experienced (or even familiar) with digital tools, the students miss out on digital literacy skills (required for the actual labor market) or access to collaborative projects and various digital resources.

To improve the teachers' digital skills, it is crucial to extend their continuous professional development to the following stage, which particularly introduces specific classroom contexts designed for different levels of school education. Training should focus on the intersection of technology, pedagogy, and subject matter, providing sensory and motivational experiences while addressing students' learning needs and expanding their digital literacy. These findings are consistent with the results of other recent studies (Warsi & Rani, 2024; Laius & Orgusaar, 2025).

This study is exploratory and has inherent limitations related to the research sample since the participants represent a cohort of teachers selected by one institution. Another limitation concerns the small number of variables. Further research could include other variables that influence the teacher's readiness for integrating digital technologies into the teaching process: the teacher's self-efficacy, the anxiety felt when forced to adapt to rapidly changing digital environments (as internal factors), or the institutional leadership support and the school's technical conditions and environment (as external factors).

Conclusions and Implications

The current research aimed to examine how teachers relate to technology in their teaching activities. The integration of technology into the teaching process is no longer

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merely a methodological option but a necessity driven by the profound transformations of the contemporary educational environment and the demands of the digital society. Although educational institutions in Romania have been equipped with digital devices in recent years, the level of teacher preparedness varies considerably, influenced by several factors: basic technical skills, attitudes toward technology, and experience with digital applications and platforms. The two-dimensional model developed in this study focused on two important dimensions: teachers' digital literacy and their experience using digital technology in teaching. The results revealed a relatively low level of digital literacy and experience, confirming the findings of other studies conducted in recent years in other countries.

The integration of technology into educational practice is an essential and valuable endeavor that must be carried out with a strategic and pedagogical approach to optimize the teaching, learning, and assessment process and to enhance the relevance and adaptability of education to the demands of the modern world. An effective teacher today must transition from being a *regular user* of technology to a *designer of digital learning experiences*.

In this context, the development of teachers' digital competencies must be a priority for the education system, and this process must be supported through continuing education programs, institutional investments in technological resources, and educational policies that encourage the effective use of technology in teaching.

The research findings open up new avenues for future investigations regarding: analyzing the impact of continuing education programs on the development of teachers' digital competencies and on the effective integration of educational technologies into teaching practices; identifying the institutional and pedagogical factors that influence the integration of digital technologies into educational practices; investigating the role of educational policies and school leadership in facilitating the integration of technologies into the educational process. Furthermore, longitudinal studies tracking the evolution of teachers' digital competencies over time and how these influence the transformation of educational practices would be useful.

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Declaration of Interest

The authors declare no competing interests.

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DEVELOPMENT AND VALIDATION OF THE PSYCHOMETRIC PROPERTIES OF THE SCHOOL LEADERSHIP PRACTICES SCALE (SLPS)

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Abstract

Before designing professional development programs aimed at improving the leadership practices of school principals, it is necessary to determine which leadership practices school principals need to improve. However, it can be said that the literature contains a limited number of measurement tools that allow for the evaluation of school principals' leadership practices, and that these tools address leadership practices within a narrow scope. For this reason, the purpose of the research conducted is to present the development process of the School Leadership Practices Scale(SLPS), which function of making sense of school principals' leadership practices based on teachers' perceptions. The measurement tool was developed in four stages: generation of the item pool; ensuring content validity; conducting a pilot study; and verifying the structure of the vehicle with the actual application. The sample of the study consisted of teachers working at the secondary school level. Exploratory factor analysis reveals that the total variance explained is 65.06%. When the absolute fit indices are evaluated as a whole, it is concluded that the developed measurement model provides a high level of fit to the data. CR values (.90-.93) indicate that all dimensions exhibit high levels of reliability. Upon the confirmation of the instrument's structure, a multidimensional model is identified, which measures school principals' leadership practices through 35 items under five factors: (a) professional ethics; (b) strategic management; (c) personal leadership resources; (d) change and data-based school development; and (e) a safe and supportive school climate.
Keywords: *school leadership practices, scale development, factor analysis*

Introduction

In our current era, change and innovation are accelerating, and societies wishing to adapt to this flow are increasingly demanding effective educational services from schools that can keep pace with change and innovation. In this context, school leaders are regarded as a significant driving force in enabling schools to provide effective educational services that respond to the demands of their surrounding communities (Bush, 2008; Daniëls et al., 2019; Dennett, 2018). Recent research has identified school leadership practices as one of the key catalysts influencing student success (Leithwood et al., 2008, 2020; Özdemir et al., 2024; Robinson et al., 2008), positively influence teacher motivation (Levin et al., 2020), and enhance school effectiveness by serving as a source of inspiration for their staff in the face of challenges (Afsouran et al., 2022; Thorn, 2012). Therefore, the success of school leaders' practices is considered a prerequisite for achieving school effectiveness, and consequently, how leadership practices can be improved has become a focal point for researchers and policymakers aiming to enhance school effectiveness.

Trends aimed at improving school leaders' practices have increased the emphasis placed on professional development efforts targeting leadership enhancement (Day & Sin, 2011), and significant budgets are allocated accordingly (Afsouran et al., 2022). In many countries, particularly the United States (US), professional development programs are being designed

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to enhance school leaders' capacities across all areas of responsibility. These programs aim to bridge theory and practice and provide learning opportunities within the framework of technical, conceptual, and interpersonal skills (Australian Institute for Teaching and School Leadership [AITSL], 2018; British Council, 2021). These initiatives are shaped around the question, "What behaviors and skills should school leaders exhibit?" and are developed in accordance with standards that outline the expected practices of school principals within the context of each country's educational system and cultural structure. These standards serve as guiding frameworks for professional development programs focused on improving school leadership practices.

Similar to countries such as the USA, Canada, and Australia, research on the development of school leadership practices is becoming increasingly important in Turkey. It has been documented that the knowledge and skills related to school management that school principals acquired from their teaching backgrounds are inadequate (Recepoğlu & Kılınç, 2014), and thus they require professional development to effectively lead the organizations they are part of (Gümüş & Bellibaş, 2020; Polat et al., 2018). The 20th National Education Council held in 2021 emphasized the need to enhance school principals' instructional leadership skills within the framework of professional development efforts (Ministry of National Education [MoNE], 2022), while the Teacher Strategy Document published in 2017 highlighted the importance of leadership skills within the framework of professional development (MoNE, 2017, p.5). In summary, over the last decade, the need for professional development programs aimed at improving the daily practices of school leaders within the Turkish National Education system has become a prominent topic in both research and policy documents (Bellibaş & Kılınç, 2022).

A review of the literature reveals that a needs analysis must be conducted prior to the design of the required professional development program (Lacerenza et al., 2017), and Indeed, professional development programs developed by taking into account the findings of needs analysis are more efficient, and therefore, greater learning is observed in the participants of these programs (Salas et al., 2012; Tannenbaum, 2002). Moreover, considering that individuals begin their development as leaders from different starting points and progress along varying trajectories over time (Day & Sin, 2011), it becomes evident that a measurement tool is needed to identify which leadership practices school leaders need to improve before designing a professional development program tailored to their needs. However, the literature indicates that measurement tools addressing leadership practices in the national literature do not adequately consider the international literature and are based on a single conceptual framework or developed as adaptations (Beycioğlu et al., 2018; Kılınç et al., 2014; Yalçın & Atasoy, 2021; Yılmaz & Börü, 2021). Therefore, the main objective of this study is to develop a comprehensive measurement tool that evaluates the leadership practices of school principals and to shed light on professional development studies related to the leadership practices of school principals.

School Leadership Practices

School leadership practices refer to the behaviors school principals exhibit in determining the steps they need to take to ensure school effectiveness (Leithwood et al., 2020) and are regarded as a fundamental professional responsibility they are expected to fulfil (Institute for Education Leadership [IEL], 2013). These practices are updated in alignment with changing demands to maximize efficiency and benefit for students. Indeed, in ensuring school effectiveness, school principals are expected not only to be instructional leaders but also to act as leaders capable of managing many dynamics that affect the educational environment. Examples include the opportunities offered by artificial intelligence in teaching and learning processes (Pradana et al., 2023) or the disadvantages of global refugee crises on schools (Türkoğlu Özdemir & Sincar, 2025). In the face of these dynamics, school leaders who can effectively demonstrate

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leadership behaviors play a driving role in ensuring school effectiveness and increasing student achievement (Leithwood et al., 2008). The behaviors expected from school leaders are categorized under common themes, forming what are referred to as leadership practices. These practices are outlined within various leadership standards (Alberta Education, 2023; AITSL, 2014; NPBEA, 2015) and frameworks (Gurr, 2015; Gurr et al., 2021; IEL, 2013; Leithwood, 2017).

The literature review shows that the first national set of standards for school leadership practices was developed in the United States in 1996 under the name ISSLC, and was subsequently updated in 2008 and 2015 to meet evolving needs (NPBEA, 2015). The standards consist of leadership practices organized under ten themes, which are defined as follows: School leaders (1) under "Mission, Vision, and Core Values," act with a student-centered approach and organize systems to realize a shared vision. (2) Under "Ethics and Professional Norms," they prioritize ethical and professional conduct and strive to ensure social justice within the school environment. (3) In the theme of "Equity and Cultural Responsiveness," they develop practices that respect cultural differences. (4) Regarding "Curriculum, Instruction, and Assessment," they take steps to increase academic achievement across classrooms in a coordinated manner. (5) In creating a "Supportive and Caring School Community for Students," they develop practices to ensure that students are educated in an environment where they are academically, socially, and emotionally supported. (6) In "Professional Capacity of School Personnel," they promote continuous development and collective learning among school staff. (7) The "Professional Community for Teachers and Staff" theme emphasizes creating embedded professional development opportunities for teachers. (8) In "Meaningful Engagement of Families and External Community," they act collaboratively, considering the needs of the school community and families. (9) Under the heading "Operations and Management," they develop strategies to manage processes for the development of students' academic and social achievement. (10) In "Continuous School Improvement," they ensure sustainability in school development and promote change, innovation, and data-driven practices. The ISLLC standards, in their updated versions, have become a seminal reference in the literature, guiding professional development and scale development efforts related to leadership practices in various countries (Choi et al., 2024; Hammad et al., 2021; Sezer, 2018).

Another significant study on school leadership practices was conducted by Leithwood (2017), who, as a result of a comprehensive research effort, proposed a framework that forms the foundation of the Ontario Leadership Framework. This framework consists of two main components: five themes outlining effective school leadership practices, and three themes describing personal leadership resources identified as the driving force behind the implementation of these practices. The leadership practices focus on: (1) Setting Directions, (2) Building Relationships and Developing People, (3) Developing the Organization to Support Desired Practices, (4) Improving the Instructional Program, (5) Securing Accountability (Leithwood, 2017, p.35). Leithwood described these practices in the following order: Establishing a shared vision for the school with high expectations; fostering communication within the school community and promoting professional development; encouraging collaboration in school improvement and creating a safe environment; implementing practices aimed at improving students' academic achievement; and ensuring both internal and external accountability among school staff. The personal leadership resources are categorized into cognitive, social, and psychological.

School Leadership Practices Scale

Although school leadership practices are framed within widely accepted models, considering the context-sensitivity of these practices, each country defines which behaviors

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leadership practices should encompass within the framework of its own education system (Gurr et al., 2007; Yasser, 2023). The behaviors associated with the identified leadership practices shed light on professional development efforts aimed at improving these practices. Before designing such professional development programs, it is essential to determine the specific needs they aim to address, which is identified by revealing the leadership practices school leaders need to improve (Schleicher, 2012). Therefore, this study aims to develop the School Leadership Practices Scale (SLPS), which serves to describe the leadership practices that school leaders in Türkiye need to develop, based on internationally recognized school leadership practices.

The foundation of this study lies in evaluating the behaviors that school leaders need to demonstrate in their practices based on teachers' perceptions, which led to adopting the "Behavioural Leadership Approach" as the theoretical basis for the scale development process. At the core of the behavioral approach is the belief that what makes leaders effective are the behaviors they exhibit (Bolden et al., 2003). Advocates of this approach identify observable actions of leader behavior and associate them with effective leadership (Yukl, 2012). It is further argued that anyone who can learn and apply these actions can become an effective leader (Koç & Topaloğlu, 2012). According to the theory, with practice-based training, individuals' behaviors can be changed to align with expectations, and they can be trained to become leaders (Gibson et al., 1996). Based on the observability of leadership behaviors, Yukl emphasized the importance of practice-based research conducted through behavior description questionnaires in identifying effective leadership behaviors. Therefore, the Behavioral Approach perspective forms the theoretical framework of this study, which aims to determine which behaviors school leaders need to improve before designing a professional development program to enhance their leadership practices, using the School Leadership Practices Scale (SLPS).

Research Aim and Research Questions

As stated before, it can be said that scale development studies that have the function of evaluating the leadership practices of school principals in the literature regarding the Turkiye context are limited. Moreover, considering the dynamic nature of the required leadership practices (AITSL, 2018), it can be stated that there is a need for an up-to-date and comprehensive scale in the field. Therefore, the purpose of this study was to develop the School Leadership Practices Scale (SLPS) in order to evaluate the behaviors of school principals during their leadership practices. In line with this purpose, it is expected that by identifying, from the perspective of teachers working at the secondary level, the leadership behaviors school principals need to improve, the findings obtained will guide professional development efforts. Based on all this data, it is aimed to answer the following questions:

1. Is the scale developed to evaluate school leadership practices valid?
2. Is the scale developed to evaluate school leadership practices reliable?
3. What are the dimensions and items of the scale developed to evaluate school leadership practices?

Research Methodology

General Background

This study was a quantitative research conducted with the aim of developing a scale. The scale development process consisted of four stages: Generation of the item pool, ensuring content validity, conducting the pilot study, and confirming the structure of the instrument through the main study (Hinkin, 1998).

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Study Groups and Data Collection

The studies regarding the steps expressed in the research process were carried out with a sample formed from teachers working in secondary public schools in the center of Gaziantep province during the 2024-2025 academic year. To obtain a rich data set from the sample, the snowball sampling method, one of the purposive sampling techniques, was adopted (Merriam, 2018). Many researchers have made different suggestions regarding how large the sample size should be in the scale development process. Hair et al. (2018) suggested that the sample size should be ten times the number of items in the item pool, Bryman and Cramer (2001) suggested five times, and Kline (2016) suggested two times. In this research, the aim was to reach a sample of 800 participants, taking into account the recommendation of Hair et al., in order to apply the draft scale form with 80 items in the item pool.

In order to administer the School Leadership Practices Scale (SLPS) to the study group, ethical approval was first obtained from the Ethics Committee for Social and Human Sciences at Gaziantep University, in accordance with the committee's decision dated 26.08.2024 and numbered 536232. The draft scale form was transferred to a Google Form, which was then administered to the study group via WhatsApp by the researchers using the Google Form application. In the process of reaching the study group, the Google form link containing the scale items was sent to the other participants via WhatsApp, based on the participants' voluntary participation and their recommendations.

In the Pilot Study (Exploratory Factor Analysis [EFA]-I) phase of the research, data were collected from 417 participants. 59.5% of the participants were female, and the mean age was 41.12±8.49 years (ranging from 22 to 65). 76% of the participants had a bachelor's degree and 24% had a master's degree. The average teaching experience among participants was 14.90±9.15 years (range 1 to 44).

A total of 798 valid participant responses were obtained for the main study. To enable a more robust and consistent testing of the measurement tool's factor structure through cross-validation (Tabachnick & Fidell, 2015), the sample was randomly divided into two equal parts. Accordingly, Exploratory Factor Analysis II (EFA-II) was conducted with the first subsample of 398 participants, while Confirmatory Factor Analysis (CFA) was carried out with the second subsample of 398 participants. In the EFA-II sample group, 62.1% of participants were female, and the mean age was calculated as 36.93 ± 7.89 years (22-62). Of the participants, 74.1% held a bachelor's degree and 25.9% held a graduate degree; the average teaching experience was found to be 10.92 ± 7.73 years (1-35). In the CFA sample, the female proportion of the participants was 65.6%, and the average age of the women was 36.97±9.22 (22-65). Of this group, 78.9% had a bachelor's degree and 21.1% had a master's degree. The average teaching experience was 11.12±8.53 years (1-40).

The sample selected for the test-retest application consisted of 30 participants. The gender distribution within this sample was balanced, with equal representation of male and female participants. The mean age of the sample was calculated as 30.47 ± 4.51 years (ranging from 22 to 39). Among the participants, 70% held a bachelor's degree and 30% held a graduate degree. The average teaching experience was found to be 7.1 ± 4.56 years (ranging from 1 to 17).

Item Pool

The development process of the School Leadership Practices Scale (SLPS) began with the creation of an item pool. This pool resulted in 80 items categorized under 11 headings created by combining the ten dimensions of leadership standards outlined in the Professional Standards

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for Educational Leaders (NPBEA, 2015) and the common aspects of the five-dimensional framework for Successful School Leadership and Personal Leadership Resources proposed by Leithwood (2017). Additionally, during the item writing process, findings from face-to-face focus group interviews conducted by the researchers with school principals–highlighting the leadership practices they perceive as necessary to improve (Türkoğlu Özdemir & Şahin, 2025) –were taken into account, along with statements from nationally published leadership scales (Beycioğlu et al., 2018; Kılınç et al., 2014; Sezer, 2018; Yalçın & Atasoy, 2021; Yılmaz & Börü, 2021). The draft scale was designed as a 5-point Likert-type instrument, with items rated as: "Never (1)," "Very Rarely (2)," "Sometimes (3)," "Most of the Time (4)," and "Always (5)." During the creation of the item pool, no reverse items were added because, as stated by DeVellis (2017), it might cause confusion for the participants.

Content Validity

To determine whether the items in the scale accurately represent the construct intended to be measured, expert opinions were obtained from a measurement and evaluation specialist and a Turkish language specialist. Based on their feedback, the language and wording of several items were checked and revised. Additionally, in order to ensure the content validity of the 80 items included in the initial draft, the opinions of eight experts in educational administration and leadership were gathered. The evaluation form presented to the experts included a four-point rating scale for each item: "not appropriate," "requires major revision," "may be appropriate with minor revision," and "completely appropriate," corresponding to scores from 1 to 4. For each item, the Item-Level Content Validity Index (I-CVI) was calculated, and for the overall scale, the Scale-Level Content Validity Index using the average method (S-CVI/Ave) was computed. Values of .78 and above are considered valid I-CVI values if reviewed by eight experts (Polit & Beck, 2006). The I-CVI for each item was calculated by dividing the number of experts who rated the item as 3 or 4 by the total number of experts. As a result of these calculations, 24 items with I-CVI values below .78 were deemed insufficient in terms of content representation and were removed from the item pool. The revised draft scale was thus updated to include 56 items. The overall S-CVI, calculated as the average of all item-level CVIs, was found to be .86, indicating that the scale possesses adequate content validity.

Pilot Study

Prior to the pilot study, a preliminary application was conducted with 10 participants. These participants were asked to identify potential item-level issues such as conceptual confusion, semantic ambiguity, handling similar behaviors, or cultural incongruity (Willis, 2015). Based on the feedback received, 8 items dealing with similar behaviors and cultural incongruity were removed from the scale. Consequently, this scale consisting of 48 items was administered.

Confirming the Structure of the Scale Through the Main Study

Confirmatory Factor Analysis (CFA) tests the theoretical accuracy of the structure obtained from EFA and evaluates how well the measurement model fits the data (Brown, 2015). In the pilot study (EFA-I), data obtained from the 48-item draft scale form were used. At the end of the sequential analysis process, a total of 12 items were removed due to not meeting the minimum factor loading threshold or due to cross-loading, and subsequent analyses continued with the remaining 36 items. In the EFA II phase, one item from the 36-item scale form was determined to lack discriminant validity and was removed. The theoretical accuracy

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and fit indices of the 35-item measurement instrument, validated in the main study, were also confirmed by Confirmatory Factor Analysis (CFA), and detailed information regarding the process is included in the findings.

Test-Retest Reliability

The aim of this method was to determine whether the measurement tool gives consistent results over time and its stability over time. It evaluates the instrument's resistance to temporal variability by examining the relationship between two sets of data collected from the same individuals at different points in time (DeVellis, 2017). This type of reliability is particularly important for constructs where individual variability is expected to be low, and it plays a critical role in determining whether the measurement tool is stable (Kline, 2016). The test-retest reliability of the instrument, confirmed through the main study, was analyzed using the finalized 35-item version of the scale. The correlation between the two datasets was assessed using the Pearson product-moment correlation coefficient (r) and the Intraclass Correlation Coefficient (ICC).

Research Results

Step I-Pilot study (EFA-I)

Within the scope of the pilot study, the EFA-I analyses were conducted using data obtained from the 48-item draft scale form. Analyses were carried out in SPSS 30 software using the Maximum Likelihood extraction method and Promax rotation technique. During the data collection process for the pilot study, a total of 450 participants were reached; following the data screening procedures, the final sample size was reduced to 417. Initially, no item exhibited a deviation from normal distribution, nor did any item exceed the skewness and kurtosis thresholds of ±1.5 or show excessively symmetric or dominant response tendencies (Kline, 2016). Subsequently, the Cronbach's Alpha coefficient for the 48-item scale was calculated as .97, indicating a high level of internal consistency (George & Mallery, 2016). A detailed item-level analysis revealed that item-total correlation values ranged between .40 and .77, demonstrating that all items exceeded the critical threshold of .30 (Nunnally & Bernstein, 1994).

During the sequential analysis process, items with factor loadings below .32 were systematically excluded from the model. Additionally, to prevent cross-loading issues, any item with a loading above .30 on more than one factor and a difference of less than .15 between its two highest factor loadings was considered non-discriminative between constructs and was thus removed from the scale. After each item removal, the analysis was rerun, and the resulting factor structure was re-evaluated. By the end of the process, a total of 12 items were excluded either for not meeting the minimum factor loading threshold or due to cross-loading, and the subsequent analyses continued with the remaining 36 items.

Within the scope of the pilot study, the suitability of the 36-item final scale for factor analysis was first assessed using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity. The KMO value obtained was .969, which indicates excellent sampling adequacy, as values above .90 are considered outstanding (Tabachnick & Fidell, 2015). The result of Bartlett's Test of Sphericity yielded a chi-square value of 11,454.192 with 630 degrees of freedom, which was found to be statistically significant at the $p < .001$ level. Additionally, the first five factors with eigenvalues greater than 1.00 explained a total of 65.321% of the variance. These findings, particularly the results of Bartlett's Test, demonstrate

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that the 36-item dataset possesses a structure suitable for factor analysis (Hair et al., 2018; Worthington & Whittaker, 2006).

Step II- EFA II

The 36-item scale was administered to a sample of 850 participants within the scope of the main study. A preliminary data screening was conducted, and the responses of 54 participants were found unsuitable for analysis and subsequently excluded. The remaining sample of 796 participants was randomly divided into two equal subgroups (n = 398 each) to allow for a more robust and consistent testing of the factor structure through cross-validation (Hair et al., 2018; Tabachnick & Fidell, 2015). EFA-II was performed on the first subsample, while CFA was conducted on the second. Descriptive statistics indicated that all 36 items had similar means and standard deviations, and their skewness and kurtosis values were within the acceptable ±1.5 range (Kline, 2016), indicating normal distribution. Thus, no item was removed at this stage. In the subsequent analyses, the Cronbach's Alpha coefficient was calculated as .96, indicating a very high level of internal consistency (George & Mallery, 2016). Moreover, it was found that the removal of any individual item did not alter the Cronbach's Alpha value, which remained stable at .96, confirming that each item contributed significantly to the reliability of the scale (DeVellis, 2017). Additionally, item-total correlations ranged from .42 to .68, indicating that each item made a substantial contribution to the overall structure of the scale (Nunnally & Bernstein, 1994).

Following this stage, EFA was conducted, and this process was conducted using the Maximum Likelihood extraction method and Promax rotation technique. During the analysis, it was found that one item had loadings greater than .30 on two separate factors, with a difference of only .06 between the two highest loadings. Based on this, the item was determined to lack discriminant validity and was removed from the scale. A final EFA was then performed on the remaining 35 items. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was calculated as .966, indicating that the sample was suitable for factor analysis (Tabachnick & Fidell, 2015). Bartlett's Test of Sphericity was found to be significant (χ^2 (595) = 8699.195; p < .001), suggesting that the variables were sufficiently interrelated to justify the application of factor analysis (Hair et al., 2018).

Reliability analyses conducted separately for the five factors revealed that the Cronbach's Alpha coefficients ranged between .89 and .92, indicating that all factors possess very high reliability (Nunnally & Bernstein, 1994). Additionally, the five factors with eigenvalues greater than 1 explained 65.06% of the total variance, which demonstrates that the explained variance is at an acceptable level (Özdamar, 2016). Findings related to the Rotated Factor Loadings and Reliability Values from EFA-II are presented in Table 1.

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Table 1
Rotated Factor Loadings and Reliability Values from EFA-II

Items	F1	F2	F3	F4	F5
I1	.82				
I3	.82				
I7	.81				
I4	.77				
I2	.75				
I5	.73				
I6	.73				
I8	.70				
I14		.83			
I10		.78			
I11		.78			
I15		.74			
I13		.72			
I9		.71			
I12		.70			
I32			.76		
I36			.76		
I31			.74		
I34			.74		
I30			.73		
I33			.73		
I35			.71		
I22				.80	
I26				.79	
I28				.79	
I29				.73	
I27				.70	
I24				.65	
I23				.62	
I16					.80
I20					.73
I18					.72
I17					.72
I19					.72
I21					.71
Eigenvalue	14.51	2.63	2.46	1.88	1.30
Explained Variance	41.45	7.52	7.01	5.36	3.71
Cumulative Explained Variance	41.45	48.97	55.98	61.35	65.06
Cronbach's Alpha	.92	.91	.89	.91	.91

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According to the factor correlation matrix obtained after rotation, positive and moderate correlations were observed among the five dimensions of the scale. The fact that all correlation values fell within the range of .30 to .70 indicates that there are meaningful relationships between the factors, yet each dimension is sufficiently distinct from the others in terms of structure (Brown, 2015).

Table 2
EFA-II Factor Correlations

	F1	F2	F3	F4	F5
F1	1.00				
F2	.55	1.00			
F3	.55	.59	1.00		
F4	.61	.68	.65	1.00	
F5	.50	.52	.62	.43	1.00

Step III-CFA

The model fit indices related to the Confirmatory Factor Analysis (CFA) were analyzed to evaluate how well the measurement model fits the data. The model fit indices obtained in the current study, along with the acceptable thresholds reported in the literature, are presented in Table 3.

Table 3
CFA Model Fit Indices

Fit Index	Obtained Value	Acceptable Range
Chi-square	592.544	Not sufficient alone; should be interpreted with other indices
Df	550	For informational purposes
p-value	.102	$p > .05$ indicates no significant difference between model and data → good fit
Chi-square/df	1.077	1–3: Excellent fit, 3–5: Acceptable fit
RMSEA	.014	.00–.05: Excellent, .06–.08: Good, >.10: Poor
RMSEA 90% CI (Low)	.000	< .08
RMSEA 90% CI (High)	.022	< .08
GFI	.923	≥ .90: Acceptable fit
AGFI	.912	≥ .90: Acceptable fit
PGFI	.806	≥ .50: Acceptable fit
SRMR	.028	≤ .08: Acceptable fit
NFI	.939	≥ .90: Acceptable fit
TLI	.995	≥ .95: Excellent fit
CFI	.995	≥ .95: Excellent fit

Upon evaluation of Table 3, it can be concluded that the developed measurement model demonstrates a high level of fit with the data (Tabachnick & Fidell, 2015), exhibits a very low error level, and can be considered valid both theoretically and statistically. The visual representation of the CFA model is shown in Figure 1.

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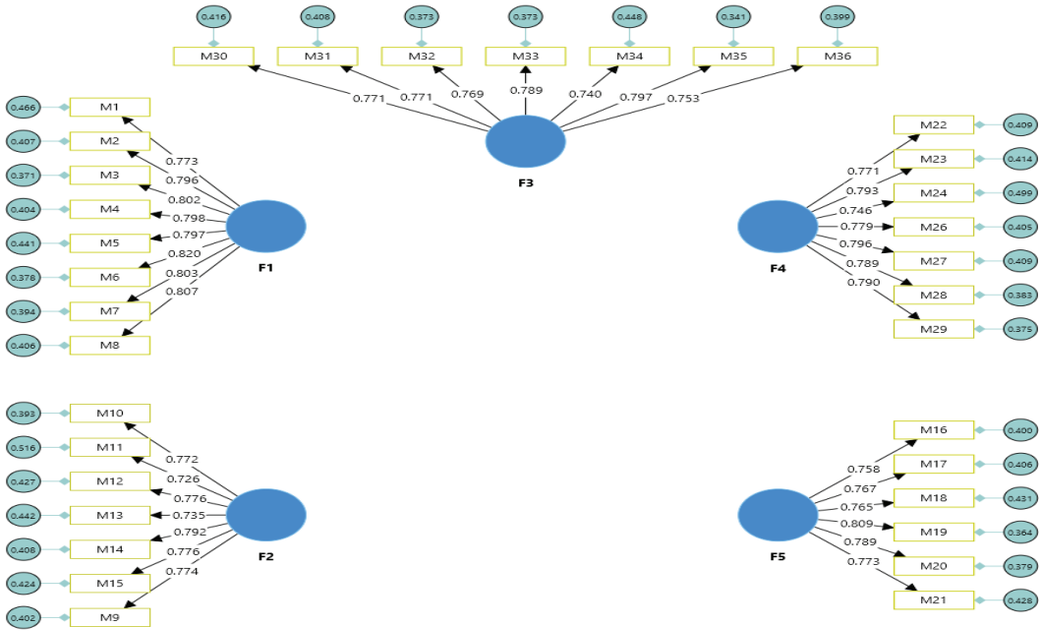
Figure 1
Standardized Factor Loadings of Items in CFA



In confirmatory factor analysis, convergent validity, a key component of construct validity, assesses the extent to which the items in the scale represent their respective latent constructs (Tabachnick & Fidell, 2015). The high standardized factor loadings obtained in the previous analysis step (.726 - .820) indicate that the items strongly load onto their theoretically assigned dimensions. Convergent validity should be evaluated not only based on factor loadings but also through the values of Average Variance Extracted (AVE) and Composite Reliability (CR) (Hair et al., 2018). Table 4 presents the findings regarding construct validity and reliability obtained in this study.

Table 4
Construct Validity and Reliability Results

Factor	Cronbach's Alpha (Standardized)	Composite Reliability (CR)	Average Variance Extracted (AVE)
F1	.934	.934	.639
F2	.908	.908	.585
F3	.911	.911	.593
F4	.916	.916	.610
F5	.901	.902	.604

The fact that all obtained AVE values exceed the .50 threshold indicates that each dimension is meaningfully represented by its respective items and that the latent constructs are sufficiently explained (Fornell & Larcker, 1981). Additionally, the CR values obtained in the model demonstrate that all dimensions exhibit a high level of reliability (Hair et al., 2018). Furthermore, the Cronbach's Alpha values reveal that the sub-dimensions of the scale possess high internal consistency and that the relationships among the items are strong (George & Mallery, 2016).

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Test-Retest Reliability

To observe whether the developed scale yielded stable results over time, test-retest reliability analyses were performed after three weeks (Nunnally & Bernstein, 1994). The application was carried out with 30 participants, meeting the minimum sample size criterion specified by Hair et al. (2018). The results obtained are given in Table 5.

Table 5
Test-Retest Reliability Findings

Factor	Pearson r (T1T2)	ICC Model	ICC Value	95% CI Lower	95% CI Upper	Interpretation
F1	.949	3.1	.937	.873	.970	High
F2	.927	3.1	.925	.848	.963	High
F3	.929	3.1	.928	.855	.965	High
F4	.927	3.1	.926	.850	.964	High
F5	.928	3.1	.919	.838	.961	High
Overall Scale	.967	3.1	.966	.931	.984	High

The Pearson correlation coefficients for all sub-factors of the scale range between .927 and .949. These values indicate a high level of stability over time for the scale. The resulting values show that the scale consistently provides accurate results and has stability over time. Furthermore, the Pearson r value for the entire scale was determined to be .967. As stated by DeVellis (2017), high test-retest correlation values indicate that the measurement tool is resistant to temporal change and maintains consistency over time. In this context, the findings show that the construct measured by the scale does not change significantly over time and that recall effects are limited. The ICC value for the overall scale was calculated as .966. Since all ICC values exceed .90, the results indicate "high reliability" (DeVellis, 2017). Each of the five factors, comprising the 35-item structure, was evaluated within its theoretical context and named accordingly. Detailed tables regarding the final structure of the scale are presented in Appendix 1.

Discussion

The School Leadership Practices Scale (SLPS) evaluates school principals' leadership practices based on teachers' perceptions across five dimensions: Professional Ethics, Strategic Management, Personal Leadership Resources, Change and Data-Based School Development, and Safe and Supportive School Climate. These practices describe the behaviors that school principals are expected to demonstrate for providing school effectiveness. Following the analyses conducted to test the scale–namely EFA-I (pilot study), EFA-II, and CFA–with the establishment of reliability through the test-retest method, the five-factor model of the SLPS has been shown to be psychometrically robust.

In constructing the item pool, a pool of 80 items was initially designed, taking into account two widely accepted conceptual frameworks that outline the leadership behaviors expected from school principals (Leithwood, 2017; NPBEA, 2015). Based on expert review (n = 8), 24 items were excluded due to insufficient content representation, and following cognitive interviews with participants (n = 10), 8 items were removed for causing conceptual confusion,

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thereby enhancing content validity. The remaining 48-item scale was administered in the pilot study (EFA-I) (n = 417). As a result of the analysis, 12 items that exhibited cross-loadings were excluded, yielding a scale with 36 items across 5 factors. The Cronbach's Alpha coefficient (.97), KMO value (.969), and Bartlett's Test of Sphericity (χ^2 = 11454.192, p < .001) confirmed the appropriateness of the dataset for factor analysis (Tabachnick & Fidell, 2015). The cumulative variance explained by factors with eigenvalues ≥1 was 65.321%, indicating that the factor structure accounted for a substantial portion of the variance and was statistically meaningful. The 36-item scale was then administered to a sample of 796 participants. To ensure a more robust and consistent testing of the factor structure via cross-validation (Hair et al., 2018), the sample was randomly divided into two equal parts. In the EFA-II (n = 398), The Cronbach's Alpha coefficient was determined to be .96, indicating very high internal consistency (Nunnally & Bernstein, 1994). One item was removed due to dual factor loading. For the remaining 35 items, the KMO value was .966, and Bartlett's Test of Sphericity (χ^2 = 8699.195, p < .001) was significant (George & Mallery, 2016). The cumulative variance explained by the components with eigenvalues ≥1 was 65.056%. In the CFA phase (n = 398), the 35-item, 5-factor structure was tested. The model demonstrated high levels of fit across absolute fit indices (χ^2 = 592.544, RMSEA = .014, SRMR = .028), incremental fit indices (CFI = .995, TLI = .995, NFI = .939), and explanatory indices (GFI = .923, AGFI = .912, PGFI = .806), indicating that the developed model fit the data very well, with low error, and could be accepted as both theoretically and statistically valid. To assess the temporal stability of the scale, a test-retest method was employed (n = 30). The resulting Person r = .967 for the entire scale, while ICC = .966. These results demonstrate that the measurement tool is not only resistant to temporal variation and stable over time but also highly reliable (DeVellis, 2017; Kline, 2016).

Studies conducted in many countries on both Eastern and Western axes have developed surveys and measurement tools that allow for the evaluation of leadership practices in the field, taking into account national professional standards (ISCLLS, etc.) or international projects (ISSPP, etc.) regarding the leadership practices of school principals (Awodiji & Naicker, 2024; Choi et al., 2022; Dellomas & Deri, 2022; Tobón et al., 2020). A common theme in these studies is the need for a multifaceted evaluation tool to improve the performance of school principals in their leadership practices in school settings and to ensure their continuous professional development. Therefore, it can be said that there is a need for a current and contemporary measurement tool that defines school leadership practices in every period. In this research, NPBEA (2015), which defines the leadership practices of school principals, and Leithwood (2017), which explains the practices of successful school leaders and the personal leadership resources that serve as the driving force behind these practices, are considered as conceptual frameworks that shed light on leadership practices. While the NPBEA sheds light on professional development studies and the development of assessment tools for school principals' leadership practices (Hammad & Al-Harthi, 2021; Sezer, 2018; Taylor, 2024; Zadorozhna-Knyagnitska et al., 2023), the framework put forward by Leithwood forms the conceptual framework of the Successful School Leadership Survey (SSLS), has been revised to date, and is considered the most comprehensive study in this field (Hitt & Tucker, 2016).

This study, based on two internationally accepted frameworks, developed the SLPS (School Principals' Leadership Assessment System) to provide an opportunity to evaluate the leadership practices of school principals, thus adding depth to the international literature and contributing to the limited number of assessment tools in the national arena, most of which are adaptation studies (Beycioğlu et al., 2018; Kılınç et al., 2014; Sezer, 2018; Yalçın & Atasoy, 2021; Yılmaz & Börü, 2021). The most striking point in the findings is the absence of a separate factor corresponding to the "Curriculum, Instruction and Assessment" and "Curriculum Improvement" dimensions included in the conceptual frameworks used. The results show that in their current practices, school leaders provide processes for instructional activities

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not directly through instructional leadership activities, but indirectly through steps aimed at improving them.

Conclusions and Implications

The results obtained from the study show that the 35-item, 5-factor School Leadership Practices Scale (SLPS) is a valid and reliable measurement tool. While the scale adds depth to the frameworks established internationally regarding leadership practices, it also emphasizes the context-specific nature of leadership behaviors and their constantly changing and transforming nature. Therefore, it is anticipated that the findings of the research can raise awareness among policy makers in order to strengthen the practices of school leaders. Furthermore, the results of this study, which examines the leadership practices of school principals during a typical school day, are likely to shed light on professional development programs designed to improve leadership practices.

One of the key limitations of this study is that the scale development process relied solely on teachers' perceptions. Future studies may expand the perspective by incorporating the views of school principals themselves as well as those of other school staff. Another limitation lies in the study's sample, which was formed using a purposive sampling method and included only teachers working at the secondary level in public schools. This non-random approach may introduce sampling bias. Therefore, future research should aim to validate the results using randomly selected samples from larger populations, including private schools and different educational levels, to enhance the generalizability of the findings. Furthermore, there is currently no evidence that SLPS scores are related to leadership effectiveness or student outcomes. The study addresses the rigorous development and validation process of the scale's internal structure (content, structure, reliability). It does not include criterion validity (e.g., linking SLPS scores to an external measure of school effectiveness or student achievement). Therefore, future research could deepen the literature by providing evidence for a relationship between SLPS scores and leadership effectiveness or student achievement

Declaration of Interest

The authors declare no competing interest

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Appendix 1

SLP Factors, Items, and Factor Loadings

School Leadership Practices Scale and items	Factor Loading
F1. Professional Ethics 1. Promotes justice and equity among school stakeholders.	.820
2. Acts with a commitment to lifelong learning, valuing teacher and student development and the public good.	.807
3. Acts in accordance with legal frameworks that protect children's rights.	.803
4. Takes responsibility for ensuring students' academic and social well-being.	.802
5. Develops communication channels characterized by effectiveness and respect.	.798
6. Creates social awareness among school stakeholders.	.797
7. Promotes ethical and professional behavior among school staff.	.796
8. Shapes actions in accordance with legal frameworks.	.773
F2. Strategic Management 9. Considers the needs of school stakeholders (students, teachers, parents, etc.) when developing practices to support school improvement.	.792
10. Assigns roles and responsibilities to teachers in developing practices that support school improvement.	.776
11. Considers teachers' opinions in the process of forming the school's vision.	.776
12. Takes into account community values and expectations in forming the school's vision.	.774
13. Uses resources (human, financial, physical, technological) efficiently and effectively to achieve the school's goals.	.772
14. Transforms school goals into a sustainable action plan.	.735
15. Monitors and evaluates the effectiveness of the action plan in achieving school goals.	.726
F3. Personal Leadership Resources 16. Takes initiative in solving problems encountered.	.797
17. Acts based on pedagogical and expert knowledge in processes related to student learning.	.789
18. Thinks critically in analyzing and interpreting problems.	.771
19. Is a good listener and sensitive in giving feedback to understand stakeholders' emotions.	.771
20. Responds to challenges with psychological resilience.	.769
21. Demonstrates knowledge and understanding of effective leadership practices.	.753
22. Understands contemporary leadership theory and applies this knowledge to school development.	.740
F4. Safe and Supportive School Climate 23. Collaborates with public and private institutions to utilize their resources in supporting school improvement.	.790
24. Eliminates internal and external risks to create a safe school environment.	.789
25. Provides mentoring support for newly appointed teachers.	.796
26. Ensures the necessary conditions (discipline, materials, classrooms, etc.) for a healthy teaching and learning process.	.779
27. Develops practices that support academic achievement without discriminating between disadvantaged and gifted students.	.746
28. Provides opportunities for teachers to develop their professional knowledge and skills.	.793
29. Supports active parental involvement in education both inside and outside the school.	.771
F5. Change and Data-Based School Development 30. Facilitates discussions among teachers on updated teaching and learning practices.	.773

31. Participates in training related to school development and receives support from expert educators.	.789
32. Follows new trends along with national and global developments in school improvement processes.	.809
33. Sustains school improvement by encouraging change and innovation among teachers and students.	.765
34. Uses multiple data sources and types in school development processes.	.767
35. Institutionalizes data-based decision-making in school development processes.	.758

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COGNITIVE–AFFECTIVE PREDICTORS OF METACOGNITIVE AWARENESS IN MATHEMATICS LEARNING

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Abstract

Mathematics learning is shaped not only by students' cognitive abilities but also by how they regulate their learning, perceive risk, and interpret failure within the learning process. This study developed a predictive model to examine how academic risk-taking and irrational beliefs predict metacognitive awareness among lower-secondary school students in mathematics. A quantitative correlational design was employed with 979 lower-secondary school students (ages 11–14) in Türkiye. Data were collected using three validated instruments: the Mathematics-Focused Academic Risk-Taking Scale (MFARTS), the Irrational Mathematics Beliefs Scale (IMBS), and the Metacognitive Awareness Inventory for Children (MAIC, Form B). Descriptive statistics, t-tests, ANOVA, and simple linear regression analyses were conducted. Results revealed moderate-to-high levels of metacognitive awareness overall. Academic risk-taking positively and significantly predicted metacognitive awareness, whereas irrational mathematics beliefs negatively predicted it. Fifth-grade students and those with higher mathematics achievement exhibited significantly greater metacognitive awareness and risk-taking tendencies. Irrational beliefs generally decreased with higher achievement, though certain sub-dimensions showed varied patterns across grade levels. No significant gender differences were found in metacognitive awareness or overall risk-taking. Overall, the results demonstrate that metacognitive awareness in mathematics is strengthened by students' willingness to engage in take academic risks but weakened by rigid, irrational beliefs about learning and failure. The findings contribute to the theoretical integration of cognitive-affective models in mathematics education and provide empirical support for pedagogical approaches that promote self-regulated learning through risk-friendly classroom climates and the reframing of maladaptive beliefs.

Keywords: *academic risk-taking, irrational beliefs, mathematics education, metacognitive awareness, lower-secondary education*

Introduction

Learning in the 21st century cannot be conceptualized as a passive process of receiving information; rather, it requires learners to actively engage with, reflect on, and regulate their learning experiences. In this context, learning processes are defined not only by the skills of knowledge-acquisition and comprehension but also by the individual's capacity to regulate, monitor, and evaluate their own learning (Efklides, 2008; Efklides & Metallidou, 2020; Nerantzaki et al., 2021; Veenman, 2015; Veenman & van Cleef, 2019; Zimmerman, 2002). Within this perspective, metacognitive awareness, defined as one's capacity to recognize, control, and regulate cognitive processes, remains a foundational construct for learning effectiveness (Flavell, 1979). Metacognitive theory emphasizes both knowing about cognition and regulating cognition, including planning, monitoring, and evaluation functions that support goal setting, strategy selection, progress checking, and outcome appraisal (Armbruster & Brown, 1984; Brown, 1980, 1987; Flavell, 1987; Flavell et al., 2001; Hartman, 2001; Pintrich, 2002; Schraw & Moshman, 1995; Veenman et al., 2004; Winne & Azevedo, 2014). This knowledge–control cycle is also described in terms of person, task, and strategy knowledge, alongside executive regulation processes that guide problem solving (Baker, 1994; Blakey & Spence, 1990; Brown, 1987; Coutinho, 2006; Hendriana et al., 2018; Muncer et al., 2022).

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Mathematics learning is a particularly informative context for examining metacognition because it involves abstract reasoning, complex problem solving, and flexible strategy use (Barzilai et al., 2023; Janssen & Lazonder, 2024; Zohar & Barzilai, 2013). Students with stronger metacognitive awareness tend to notice errors, revise strategies, and persist through difficulty, treating mistakes as informative feedback rather than as endpoints (Alivio & Tan, 2025; Desender & Sasanguie, 2022; Efklides & Metallidou, 2020; Mevarech & Paz-Baruch, 2022; Ozdemir et al., 2024; Thi-Nga et al., 2024; Zohar & David, 2008). In contrast, lower metacognitive awareness is associated with more rote or intuitive approaches, weaker error monitoring, and earlier disengagement (Desender & Sasanguie, 2022).

Alongside cognitive regulation, students' affective beliefs and dispositions shape how they engage with mathematical challenges. Irrational beliefs, rigid, unrealistic, or distorted evaluations about the self, tasks, and achievement, are theorized within REBT as assumptions that can undermine adaptive emotions and behavior, especially under performance pressure (Dryden, 2010, 2013, 2024; Ellis, 1995; Ellis et al., 2010). In school settings, such beliefs may appear as absolutist standards (e.g., "failure is unacceptable" or "mistakes prove inadequacy") and are linked to lower motivation, risk avoidance, and diminished self-efficacy (Li & Yuan, 2022; Morsanyi et al., 2019; Zhou et al., 2022, 2023). Because these beliefs can shift attention from task-focused monitoring to threat-focused avoidance, they may constrain students' use of metacognitive strategies and their willingness to remain engaged in the face of uncertainty (Bester & Kufakunesu, 2021; Diale & Victor-Aigbodion, 2022; Gómez-Chacón, 2014; Pennequin et al., 2020).

A closely related behavioral dimension is academic risk-taking, defined as the tendency to attempt novel strategies, tolerate mistakes, and participate actively despite the possibility of failure (Clifford, 1988; Clifford & Chou, 1991). In mathematics, risk-taking supports the exploration of alternative approaches, learning from errors, and the development of adaptive problem-solving repertoires (Arslan, 2021; Arslan & Coşkun, 2023; Avcı & Özenir, 2016; Beghetto et al., 2021; Beghetto & Glăveanu, 2022; Eke & George, 2025; Pimta et al., 2009; Robinson, 2012). Conversely, low risk-taking is associated with avoiding errors, choosing "safe" strategies, and narrowing learning opportunities (Erbas & Bas, 2015; Sharma, 2015). Conceptually, metacognitive awareness and risk-taking are mutually supportive: monitoring and regulating one's thinking can increase the confidence needed to engage in uncertain tasks, whereas rigid, irrational beliefs can suppress both cognitive flexibility and the willingness to take learning risks (Doruk et al., 2018; Desoete & De Craene, 2019; Lingel et al., 2019; Özsoy, 2011; Yildiz et al., 2018).

Despite growing emphasis on integrating cognitive and affective processes in learning research, studies that consider metacognitive awareness, academic risk-taking, and irrational beliefs together, particularly in the Turkish lower-secondary context, remain limited, with prior work often examining these variables separately (İlhan & Çetin, 2013; Karakelle & Saraç, 2007; Kaya, 2017). Building on self-regulation and metacognition frameworks (Brown, 1987; Flavell, 1979; Winne & Azevedo, 2014) and contemporary mathematics education perspectives highlighting cognition–affect coupling (Efklides, 2008; Efklides & Metallidou, 2020; Zohar & Barzilai, 2013), the present study addresses this gap by examining the direct predictive associations among these constructs. Specifically, the study tests whether academic risk-taking positively predicts metacognitive awareness and whether irrational beliefs negatively predict metacognitive awareness, using regression-based analyses aligned with these direct hypotheses (Aydın & Özgeldi, 2024; Beghetto, 2021; Dryden & Ellis, 2023; Lee, 2024; Sharma, 2015). By clarifying these direct links, the study aims to inform instructional designs that strengthen the use of metacognitive strategies, foster risk-friendly learning climates, and support the transformation of maladaptive beliefs in mathematics classrooms (Kramarski, 2008; Kramarski et al., 2021; Mevarech & Paz-Baruch, 2022; Zohar & Barzilai, 2013).

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Research Aim and Research Questions

The aim of this study was to examine lower-secondary school students' levels of metacognitive awareness, mathematics-focused academic risk-taking behaviors, and irrational mathematics beliefs, and to examine the relationships and predictive effects among them. Specifically, the study aimed to:

RQ1. What is the level of lower-secondary school students' metacognitive awareness?

RQ2. Do lower-secondary school students' metacognitive awareness levels differ significantly according to gender, grade level, and mathematics achievement scores?

RQ3. What is the level of lower-secondary school students' mathematics-focused academic risk-taking (total score and sub-dimensions)?

RQ4. Do lower-secondary school students' mathematics-focused academic risk-taking levels (total score and sub-dimensions) differ significantly according to gender, grade level, and mathematics achievement scores?

RQ5. What is the level of lower-secondary school students' irrational mathematics beliefs (total score and sub-dimensions)?

RQ6. Do lower-secondary school students' irrational mathematics beliefs levels (total score and sub-dimensions) differ significantly according to gender, grade level, and mathematics achievement scores?

RQ7. Does mathematics-focused academic risk-taking significantly predict lower-secondary school students' metacognitive awareness?

RQ8. Do irrational mathematics beliefs significantly predict lower-secondary school students' metacognitive awareness?

Research Methodology

Design

This study employed a quantitative correlational survey design to examine relationships among lower-secondary school students' metacognitive awareness, mathematics-focused academic risk-taking behaviors, and irrational mathematics beliefs. Correlational survey designs are used to determine the direction and strength of associations among two or more variables (Creswell & Creswell, 2017; Karasar, 2022). Data were collected during the 2022–2023 academic year. In addition to correlation analyses, predictive relationships among the variables were tested using linear regression. The study was grounded in contemporary learning perspectives that emphasize the interaction of cognitive regulation and affective processes in learning; accordingly, metacognitive awareness was conceptualized as a cognitive-regulatory construct intertwined with students' affective dispositions and belief systems (Efklides, 2008; Veenman, 2015).

Participants

The study group consisted of 979 students enrolled in public lower-secondary schools in Istanbul, Türkiye. Participants were between 11 and 14 years old and included students from Grades 5 through 8. Participation was voluntary, parental consent was obtained, and the research procedures were conducted with ethics committee approval.

A convenience sampling strategy was employed due to institutional access constraints and voluntary school participation, which is common in school-based correlational research (Fraenkel et al., 2012). The final sample reflects the total number of students who met the inclusion criteria and were available during the data collection period. The adequacy of sample size was evaluated with respect to the planned analyses (correlational analyses, group

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comparisons such as t-tests and ANOVA, and regression), for which methodological guidelines recommend minimum sample sizes well below the present sample (Fraenkel et al., 2012). In addition, because multi-item scales were used, the item-to-sample ratio exceeded commonly recommended thresholds (e.g., 1:5–1:10) for stable statistical estimation (Tabachnick & Fidell, 2013). Although convenience sampling limits generalizability, transparent reporting supports interpretation of the findings within the sampled population (Fraenkel et al., 2012). The demographic characteristics of the participants are presented in Table 1.

Table 1
Demographic Characteristics of the Participants

Variable	Category	*f*	%
Gender	Female	485	49.5
	Male	494	50.5
Grade Level	5th grade	219	22.4
	6th grade	249	25.4
	7th grade	270	27.6
	8th grade	241	24.6
Mathematics Achievement Score	0- 44	73	7.5
	45-54	120	12.3
	55-69	206	21.0
	70-84	267	27.3
	85-100	313	32.0
Total		979	100.0

Notes: f = frequency; % = percentage.

As presented in Table 1, the gender distribution of the participants was nearly balanced, with female students constituting 49.5% and male students 50.5% of the sample. This indicates that the sample was well distributed by gender.

Regarding grade level, the participants were relatively evenly distributed across grades, with 22.4% in the 5th grade, 25.4% in the 6th grade, 27.6% in the 7th grade, and 24.6% in the 8th grade. This balanced distribution suggests that all grade levels were adequately represented in the study.

In terms of mathematics achievement, the largest proportion of students (32.0%) fell within the 85–100 score range, followed by those scoring between 70–84 (27.3%) and 55–69 (21.0%). Overall, the majority of participants (80.3%) demonstrated mathematics achievement scores of 55 or above, with a substantial proportion scoring 70 or above. This distribution indicates that the sample predominantly consisted of students with moderate to high levels of mathematics achievement.

Instruments

The research data were collected using three instruments: the Mathematics-Focused Academic Risk-Taking Scale (MFARTS), the Irrational Mathematics Beliefs Scale (IMBS), and the Metacognitive Awareness Inventory for Children (MAIC; Form B). A Personal Information Form developed by the researchers was also administered to collect demographic data.

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The Personal Information Form was developed by the researchers to obtain demographic data, including gender (female, male), grade level (5th, 6th, 7th, and 8th grades), mathematics achievement score (0–44, 45–54, 55–69, 70–84, and 85–100), and parents' educational status (primary school, lower-secondary school, high school, university, and postgraduate).

The reliability of all scales used in the study was assessed using Cronbach's alpha. The reference ranges for interpreting Cronbach's alpha values are presented in Table 2 (Alpar, 2013).

Table 2
Reference Ranges for Cronbach's Alpha Coefficient

Cronbach's α Range	Interpretation
0< α <0.40	Not Reliable
0.40< α <0.60	Low Reliability
0.60< α <0.80	Quite Reliable
0.80< α <1.00	High Reliability

Notes: Cronbach's α values indicate the internal consistency reliability of a scale. Adapted from Alpar (2013).

Mathematics-Focused Academic Risk-Taking Scale (MFARTS)

The Mathematics-Focused Academic Risk-Taking Scale (MFARTS) was developed by İlhan and Çetin (2013). Content and face validity were established through expert review. The scale consists of 24 items organized under three subdimensions: Tendency to Prefer Challenging Tasks (TPCT), Tendency for Negativity After Failure (TNAF), and Tendency to Recover After Failure (TRAF).

The reliability of the scale was examined using internal consistency, split-half, and test–retest methods. Item analysis indicated that corrected item–total correlations ranged between .40 and .73, and all items significantly differentiated between the upper and lower 27% groups. The Cronbach's alpha coefficient for the overall scale was reported as .84. Reliability coefficients obtained in the present study for the MFARTS and its subdimensions are presented in Table 3.

Table 3
Reliability Analysis Results for the Mathematics-Focused Academic Risk-Taking Scale (MFARTS)

Scale / Subdimension	Cronbach's α
Tendency to Prefer Challenging Tasks (TPCT)	.851
Tendency for Negativity After Failure (TNAF)	.832
Tendency to Recover After Failure (TRAF)	.843
Overall Scale	.837

Note: Cronbach's α values indicate the internal consistency reliability of the MFARTS and its subdimensions.

As shown in Table 3, all Cronbach's alpha coefficients exceeded .80, indicating a high level of internal consistency reliability for both the overall scale and its subdimensions.

Irrational Mathematics Beliefs Scale (IMBS)

The Irrational Mathematics Beliefs Scale (IMBS) was developed by Kaya (2017). Content and face validity were established through expert review. The scale consists of 20 items and includes four subdimensions: Beliefs Related to Reasons (BRR), Restrictive Beliefs

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(RB), Chance Tendency (CT), and Control Power Tendency (CPT). All items are rated on a 5-point Likert scale.

The internal consistency coefficients reported for the original scale were .85 for BRR, .78 for RB, .71 for CT, and .66 for CPT, with an overall Cronbach's alpha coefficient of .81. Item–total correlations were found to be significant, indicating satisfactory item discrimination. Reliability coefficients obtained in the present study for the IMBS are presented in Table 4.

Table 4
Reliability Analysis Results for the Irrational Mathematics Beliefs Scale (IMBS)

Scale / Subdimension	Cronbach's α
Beliefs Related to Reasons (BRR)	.821
Restrictive Beliefs (RB)	.796
Chance Tendency (CT)	.813
Control Power Tendency (CPT)	.689
Overall Scale	.811

Note: Cronbach's α values indicate the internal consistency reliability of the IMBS and its subdimensions.

As shown in Table 4, BRR (.821), CT (.813), and the overall scale (.811) demonstrated high reliability, while RB (.796) demonstrated quite reliable and CPT (.689) demonstrated quite reliable levels of internal consistency, all indicating satisfactory measurement quality for the present study.

Metacognitive Awareness Inventory for Children (MAIC)

The Metacognitive Awareness Inventory for Children (MAIC) was adapted into Turkish by Karakelle and Saraç (2007) from the Junior Metacognitive Awareness Inventory (Jr. MAI) originally developed by Sperling et al. (2002). The validity and reliability of the scale were examined through item–total correlations, lower–upper group comparisons, test–retest reliability, and internal consistency analyses. The findings indicated that the scale provides valid and reliable measurements.

Form B, which was used in the present study, consists of 18 items rated on a 5-point Likert scale. The Cronbach's alpha coefficient reported for Form B in the adaptation study was .80. The reliability coefficient obtained in the present study for MAIC (Form B) is presented in Table 5.

Table 5
Reliability Analysis Results for the Metacognitive Awareness Inventory for Children (MAIC)

Scale	Cronbach's α
MAIC (Form-B)	.791

Note: Cronbach's α values indicate the internal consistency reliability of the scale.

As shown in Table 5, the Cronbach's alpha coefficient of .791 indicates a quite reliable level of internal consistency (George & Mallery, 2010), which is slightly below the high reliability threshold of .80 but remains within an acceptable range for the present study.

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Data Analysis

The data required for the study were collected through questionnaires administered to the participants. Descriptive results were used to summarize responses to the Personal Information Form and the measurement scales. Frequency analyses were conducted to describe demographic characteristics, while means and standard deviations were calculated for scale scores.

The internal consistency reliability of the measurement instruments was assessed using Cronbach's alpha coefficient. Prior to inferential analyses, the normality of score distributions for the Mathematics-Focused Academic Risk-Taking Scale (MFARTS), the Irrational Mathematics Beliefs Scale (IMBS), and the Metacognitive Awareness Inventory for Children (MAIC; Form B) was examined. Normality was evaluated using the Kolmogorov–Smirnov test as well as skewness and kurtosis coefficients. The Kolmogorov–Smirnov test results were non-significant ($p > .05$), and skewness and kurtosis values fell within the range of −1 to +1 (Tabachnick & Fidell, 2013), indicating that the distributions of the scale scores approximated normality.

Based on these results, parametric statistical techniques were employed. Differences in scale scores according to demographic variables were examined using independent-samples t-tests and one-way analyses of variance (ANOVA). In addition, predictive relationships among MFARTS, IMBS, and MAIC (Form B) were examined using linear regression analysis. For all statistical analyses, a 95% confidence interval and a significance level of .05 were adopted.

Table 6
Normality Test Results for the Study Scales

Scale	Skewness	Kurtosis	Kolmogorov-Smirnov
MFARTS	-0.531	-0.221	2.838
IMBS	-0.912	0.326	2.741
MAIC (Form-B)	-0.526	0.445	2.921

Note: Skewness and kurtosis values between −1 and +1 indicate approximate normality (Tabachnick & Fidell, 2013). $p > .05$.

Based on the results presented in Table 6, the skewness and kurtosis coefficients for all scales fell within the acceptable range of −1 to +1, indicating that the distributions of the scale scores approximated normality. In addition, the Kolmogorov–Smirnov test results were non-significant ($p > .05$), further supporting the assumption of normal distribution.

Accordingly, parametric statistical methods were employed in the analyses. Differences in scale scores based on demographic variables were examined using independent-samples t-tests and one-way analyses of variance (ANOVA). Furthermore, the relationships among the Mathematics-Focused Academic Risk-Taking Scale (MFARTS), the Irrational Mathematics Beliefs Scale (IMBS), and the Metacognitive Awareness Inventory for Children (MAIC; Form B) were examined using linear regression analysis. For all statistical analyses, a 95% confidence interval and a significance level of .05 were adopted.

Research Results

Metacognitive Awareness

The mean and standard deviation values for the metacognitive awareness measured by the MAIC (Form B) are presented in Table 7.

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Table 7
Descriptive Results for the Metacognitive Awareness Inventory for Children (MAIC)

Scale	*M*	*SD*
MAIC (Form-B)	3.78	1.11

Notes: M = mean; *SD* = standard deviation.

As shown in Table 7, the overall mean score for metacognitive awareness was 3.78 (on a 5-point scale), indicating a moderate-to-high level of metacognitive awareness among the participants.

Metacognitive Awareness by Gender

The independent-samples t-test results examining gender differences in metacognitive awareness are presented in Table 8.

Table 8
t-Test Results for Metacognitive Awareness (MA) by Gender

Gender	*N*	*M*	*SD*	*t*	*p*	Effect Size (Cohen's *d*)
Female	485	3.68	0.62	1.73	.08	0.11
Male	494	3.62	0.58			

Notes: M = mean; *SD* = standard deviation.

As shown in Table 8, the difference in metacognitive awareness scores between female and male students was not statistically significant, $t(977) = 1.73$, $p > .05$, indicating comparable levels of metacognitive awareness across genders.

Metacognitive Awareness by Grade Level

The results of the one-way ANOVA examining differences in metacognitive awareness across grade levels are presented in Table 9.

Table 9
ANOVA Results for Metacognitive Awareness (MA) by Grade Level

Grade	*N*	*M*	*SD*	*F*	*p*	Post-hoc
5th grade	219	3.88	0.57	16.23	< .001*	5>6,7,8
6th grade	249	3.55	0.57			
7th grade	270	3.57	0.59			
8th grade	241	3.63	0.62			

Note: M = mean; *SD* = standard deviation. Post-hoc comparisons indicate statistically significant differences between the specified grade levels at $*p < .05$.

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The ANOVA results indicated a statistically significant difference in metacognitive awareness across grade levels, $F(3, 975) = 16.23$, $p < .001$. Scheffé post-hoc comparisons revealed that 5th-grade students scored significantly higher than students in Grades 6, 7, and 8.

Metacognitive Awareness by Mathematics Achievement Score

The ANOVA results examining differences in metacognitive awareness by mathematics achievement score are presented in Table 10.

Table 10
ANOVA Results for Metacognitive Awareness (MA) by Mathematics Achievement Score

Mathematics Achievement Score	*N*	*M*	*SD*	*F*	*p*	Post-hoc
0-44	73	3.43	0.67			
45-54	120	3.56	0.56			
55-69	206	3.59	0.56	6.94	< .001*	85-100> 0-44
70-84	267	3.64	0.63			
85-100	313	3.78	0.58			

Notes: *M* = mean; *SD* = standard deviation. Post-hoc comparisons indicate statistically significant differences at *$p < .05$.

The results showed a significant effect of mathematics achievement on metacognitive awareness, $F(4, 974) = 6.94$, $p < .001$. Post-hoc analyses indicated that students with achievement scores in the 85–100 range demonstrated significantly higher metacognitive awareness than those in the 0–44 range.

Mathematics-Focused Academic Risk-Taking

Descriptive results for the MFARTS and its subdimensions are presented in Table 11.

Table 11
Descriptive Results for the Mathematics-Focused Academic Risk-Taking Scale (MFARTS)

Scale / Subdimension	*M*	*SD*
Tendency to Prefer Challenging Tasks (TPCT)	3.07	1.26
Tendency for Negativity After Failure (TNAF)	3.01	1.21
Tendency to Recover After Failure (TRAF)	3.42	1.37
Overall Scale	3.16	1.24

Notes: *M* = mean; *SD* = standard deviation.

Overall, students demonstrated moderate levels of mathematics-focused academic risk-taking, with the highest mean observed for the recovery after failure subdimension (TRAF; *M*=3.42).

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Mathematics-Focused Academic Risk-Taking by Gender

The independent-samples t-test results examining whether students' Mathematics-Focused Academic Risk-Taking Scale (MFARTS) scores differed by gender are presented in Table 12.

Table 12
t-Test Results for the Mathematics-Focused Academic Risk-Taking Scale (MFARTS) by Gender

Scale / Subdimension	Gender	*N*	*M*	*SD*	*t*	*p*	Effect Size (Cohen's d)
TPCT	Female	485	3.05	0.68	-1.64	.10	0.03
	Male	494	3.12	0.65			
TNAF	Female	485	3.07	0.98	2.15	.03	0.22
	Male	494	2.94	0.93			
TRAF	Female	485	3.63	0.98	1.22	.22	0.20
	Male	494	3.56	0.92			
Overall Scale	Female	485	3.25	0.56	1.26	.20	0.20
	Male	494	3.21	0.56			

Note: M = mean; *SD* = standard deviation. Effect sizes are reported as Cohen's *d*.

As seen in Table 12, the difference between female and male students in terms of overall MFARTS scores was not statistically significant ($t = 1.26$, $p > .05$). In other words, mathematics-focused academic risk-taking levels were similar across gender groups.

Similarly, no statistically significant gender difference was found for the TPCT (Tendency to Prefer Challenging Tasks) subdimension ($t = -1.64$, $p > .05$). This finding indicates that female and male students demonstrated similar tendencies to prefer challenging mathematical tasks.

However, a statistically significant difference was observed for the TNAF (Tendency for Negativity After Failure) subdimension ($t = 2.15$, $p < .05$). When mean scores were examined, female students showed greater negativity after failure than male students. Nevertheless, the effect size indicated that this difference was small.

For the TRAF (Tendency to Recover After Failure) subdimension, the difference between female and male students was not statistically significant ($t = 1.22$, $p > .05$). This result indicates that recovery after failure tendencies were similar across genders.

Mathematics-Focused Academic Risk-Taking Scale (MFARTS) by Grade Level

The ANOVA results examining the differentiation of MFARTS scores by grade level are presented in Table 13.

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Table 13

ANOVA Results for the Mathematics-Focused Academic Risk-Taking Scale (MFARTS) by Grade Level

Scale / Subdimension	Grade	*N*	*M*	*SD*	*F*	*p*	Post-hoc
TPCT	5th grade	219	3.38	0.64	23.14	< .001*	5>6,7,8
	6th grade	249	3.11	0.63			
	7th grade	270	2.99	0.62			
	8th grade	241	2.91	0.68			
TRAF	5th grade	219	4.02	0.80	26.42	< .001*	5>6,7,8
	6th grade	249	3.62	0.93			
	7th grade	270	3.45	0.90			
	8th grade	241	3.35	1.04			
Overall Scale	5th grade	219	3.45	0.50	21.67	< .001*	5>6,7,8
	6th grade	249	3.27	0.54			
	7th grade	270	3.16	0.49			
	8th grade	241	3.06	0.63			

Notes: M = mean; *SD* = standard deviation. *$p < .05$. Only statistically significant Post-hoc comparisons are reported.

As seen in Table 13, the difference in overall MFARTS scores across grade levels was statistically significant ($F = 21.67$, $p < .001$). This finding indicates that mathematics-focused academic risk-taking levels differed significantly according to grade level. Post hoc (Scheffé) comparisons revealed that 5th-grade students demonstrated significantly higher overall MFARTS scores than students in the 6th, 7th, and 8th grades.

Similarly, statistically significant grade-level differences were observed for the TPCT (Tendency to Prefer Challenging Tasks) subdimension ($F = 23.14$, $p < .001$). Post hoc comparisons indicated that 5th-grade students demonstrated significantly higher tendencies to prefer challenging mathematical tasks compared to students in the upper grades.

For the TRAF (Tendency to Recover After Failure) subdimension, a statistically significant grade-level difference was also observed ($F = 26.42$, $p < .001$). Post hoc results showed that 5th-grade students demonstrated significantly higher recovery after failure tendencies compared to students in Grades 6–8.

Mathematics-Focused Academic Risk-Taking by Mathematics Achievement Score

The one-way ANOVA results examining whether students' Mathematics-Focused Academic Risk-Taking Scale (MFARTS) scores differed according to mathematics achievement levels are presented in Table 14.

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Table 14
ANOVA Results for Mathematics-Focused Academic Risk-Taking Scale (MFARTS) by Mathematics Achievement Score

Scale / Subdimension	Mathematics Achievement Score	*N*	*M*	*SD*	*F*	*p*	Post-hoc
TPCT	0-44	73	2.89	0.67	8.37	< .001*	85-100>all
	45-54	120	2.96	0.66			
	55-69	206	3.04	0.68			
	70-84	267	3.05	0.64			
	85-100	313	3.25	0.64			
TNAF	0-44	73	2.89	0.91	2.78	.02*	45-54> 0-44, 85-100
	45-54	120	3.17	0.78			
	55-69	206	3.04	0.95			
	70-84	267	3.05	0.95			
	85-100	313	2.89	1.02			
TRAF	0-44	73	3.28	1.06	15.84	< .001*	85-100>all
	45-54	120	3.29	0.92			
	55-69	206	3.48	0.95			
	70-84	267	3.55	0.96			
	85-100	313	3.90	0.85			
Overall Scale	0-44	73	3.02	0.70	6.98	< .001*	85-100>all
	45-54	120	3.14	0.58			
	55-69	206	3.18	0.57			
	70-84	267	3.22	0.54			
	85-100	313	3.35	0.50			

Note. M = mean; *SD* = standard deviation. Post-hoc comparisons indicate statistically significant differences at *$p < .05$.

As seen in Table 14, the overall MFARTS scores differed significantly according to mathematics achievement level ($F = 6.98$, $p < .001$). Post hoc (Scheffé) comparisons revealed that students in the 85–100 achievement group demonstrated significantly higher overall mathematics-focused academic risk-taking levels than students in all other achievement groups.

Similarly, statistically significant differences were observed for the TPCT (Tendency to Prefer Challenging Tasks) subdimension ($F = 8.37$, $p < .001$). Post hoc results indicated that students with mathematics achievement scores between 85–100 reported higher tendencies to prefer challenging mathematical tasks compared to students in the lower achievement groups.

For the TNAF (Tendency for Negativity After Failure) subdimension, a statistically significant difference was also observed ($F = 2.78$, $p < .05$). Post hoc comparisons showed that students in the 45–54 achievement group reported higher negativity after failure compared to students in the 0–44 and 85–100 achievement groups.

In addition, statistically significant differences were found for the TRAF (Tendency to Recover After Failure) subdimension ($F = 15.84$, $p < .001$). Post hoc results indicated that students in the 85–100 achievement group demonstrated significantly higher recovery after failure tendencies than students in all other achievement groups.

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Irrational Mathematics Beliefs

The descriptive results for the Irrational Mathematics Beliefs Scale (IMBS) and its subdimensions are presented in Table 15.

Table 15
Descriptive Results for the Irrational Mathematics Beliefs Scale (IMBS)

Scale / Subdimension	*M*	*SD*
Beliefs Related to Reasons (BRR)	2.57	1.38
Restrictive Beliefs (RB)	3.58	1.29
Chance Tendency (CT)	2.15	1.41
Control Power Tendency (CPT)	3.41	1.50
Overall Scale	2.67	1.47

Notes: M = mean; *SD* = standard deviation.

As seen in Table 15, the overall mean score for irrational mathematics beliefs was 2.67. When the subdimensions were examined, the highest mean score was observed for Restrictive Beliefs (RB) (*M* = 3.58), followed by Control Power Tendency (CPT) (*M* = 3.41). In contrast, the lowest mean score was observed for Chance Tendency (CT) (*M* = 2.15). The mean score for Beliefs Related to Reasons (BRR) was 2.57.

Overall, these results indicate that restrictive beliefs and control-related tendencies were relatively more prominent compared to chance-related beliefs among the participants.

Irrational Mathematics Beliefs by Gender

The independent-samples t-test results examining gender differences in Irrational Mathematics Beliefs Scale (IMBS) scores and its subdimensions are presented in Table 16.

Table 16
t-Test Results for the Irrational Mathematics Beliefs Scale (IMBS) by Gender

Scale / Subdimension	Gender	*N*	*M*	*SD*	*t*	*p*	Effect Size (Cohen's d)
BRR	Female	485	2.59	1.16	0.52	.60	< 0.001
	Male	494	2.55	1.11			
RB	Female	485	3.59	0.85	0.19	.98	0.01
	Male	494	3.58	0.86			
CT	Female	485	2.00	0.87	-3.11	.001	0.02
	Male	494	2.18	0.88			
CPT	Female	485	3.40	1.05	0.43	.66	0.04
	Male	494	3.37	1.05			
Overall Scale	Female	485	2.89	0.57	-0.76	.44	0.03
	Male	494	2.92	0.55			

Notes: M = mean; *SD* = standard deviation. Effect sizes are reported as Cohen's *d*.

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As shown in Table 16, no statistically significant gender difference was found for the overall IMBS score ($t = -0.76$, $p > .05$).

Similarly, no statistically significant gender differences were observed for the Beliefs Related to Reasons (BRR) subdimension ($t = 0.52$, $p > .05$), the Restrictive Beliefs (RB) subdimension ($t = 0.19$, $p > .05$), and the Control Power Tendency (CPT) subdimension ($t = 0.43$, $p > .05$).

However, a statistically significant gender difference was found for the Chance Tendency (CT) subdimension ($t = -3.11$, $p < .05$). When mean scores were examined, male students ($M = 2.18$) demonstrated higher chance tendency beliefs compared to female students ($M = 2.00$).

When effect sizes were examined, all Cohen's d values indicated small effect sizes, suggesting that the magnitude of gender differences was limited.

Irrational Mathematics Beliefs by Grade Level

The ANOVA results examining grade-level differences in Irrational Mathematics Beliefs Scale (IMBS) scores and its subdimensions are presented in Table 17.

Table 17
ANOVA Results for Irrational Mathematics Beliefs (IMBS) by Grade Level

Scale / Subdimension	Grade	*N*	*M*	*SD*	*F*	*p*	Post-hoc
BRR	5th grade	219	2.18	1.05	15.83	< .001*	8>5,6 7>5
	6th grade	249	2.49	1.11			
	7th grade	270	2.74	1.07			
	8th grade	241	2.82	1.21			
RB	5th grade	219	3.90	0.76	16.42	< .001*	5>6,7,8
	6th grade	249	3.57	0.85			
	7th grade	270	3.46	0.83			
	8th grade	240	3.45	0.89			
CT	5th grade	219	2.21	0.93	3.61	.01*	5>6,7,8
	6th grade	249	2.10	0.91			
	7th grade	270	2.10	0.89			
	8th grade	240	1.96	0.77			

Notes: M = mean; SD = standard deviation. *$p < .05$. Only statistically significant Post-hoc comparisons are reported.

As shown in Table 17, statistically significant grade-level differences were observed for several IMBS subdimensions.

For the Beliefs Related to Reasons (BRR) subdimension, a statistically significant difference was found across grade levels ($F = 15.83$, $p < .001$). Post-hoc comparisons indicated that 8th-grade students had significantly higher BRR scores than 5th- and 6th-grade students, and 7th-grade students had significantly higher scores than 5th-grade students.

For the Restrictive Beliefs (RB) subdimension, a statistically significant difference was also observed ($F = 16.42$, $p < .001$). Post-hoc comparisons showed that 5th-grade students demonstrated significantly higher restrictive belief scores than students in Grades 6, 7, and 8.

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For the Chance Tendency (CT) subdimension, a statistically significant grade-level difference was identified ($F = 3.61$, $p < .05$). Post-hoc comparisons indicated that 5th-grade students had significantly higher chance tendency scores compared to students in Grades 6, 7, and 8.

Overall, these findings indicate that irrational mathematics belief patterns varied across grade levels, with different subdimensions demonstrating distinct grade-related trends.

Irrational Mathematics Beliefs by Mathematics Achievement Score

The ANOVA results examining differences in students' Irrational Mathematics Beliefs Scale (IMBS) scores and its subdimensions according to mathematics achievement score are presented in Table 18.

Table 18

ANOVA Results for Irrational Mathematics Beliefs (IMBS) by Mathematics Achievement Score

Scale / Subdimension	Mathematics Achievement Score	*N*	*M*	*SD*	*F*	*p*	Post-hoc
BRR	0-44	73	2.96	1.05	15.31	< .001*	0-44> 70-84, 85-100
	45-54	120	2.90	1.06			
	55-69	206	2.76	1.14			
	70-84	267	2.58	1.15			
	85-100	313	2.22	1.07			
RB	0-44	73	3.39	0.90	8.24	< .001*	85-100> 0-44
	45-54	120	3.49	0.83			
	55-69	205	3.47	0.83			
	70-84	267	3.51	0.88			
	85-100	313	3.80	0.81			
CT	0-44	73	2.29	0.92	4.41	< .001*	0-44, 45-54>85-100
	45-54	120	2.33	0.94			
	55-69	205	2.10	0.86			
	70-84	267	2.06	0.86			
	85-100	313	1.97	0.86			

Note: *M* = mean; *SD* = standard deviation. *$p < .05$. Only statistically significant Post-hoc comparisons are reported.

As shown in Table 18, statistically significant differences were observed across mathematics achievement score groups for all IMBS subdimensions reported in the table.

For the Beliefs Related to Reasons (BRR) subdimension, a statistically significant difference was found across achievement score groups ($F = 15.31$, $p < .001$). Post-hoc comparisons indicated that students with mathematics achievement scores between 0–44 had significantly higher BRR scores than students with scores between 70–84 and 85–100.

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For the Restrictive Beliefs (RB) subdimension, a statistically significant difference was also observed (F = 8.24, p < .001). Post-hoc comparisons revealed that students with mathematics achievement scores between 85–100 had significantly higher RB scores than students with scores between 0–44.

For the Chance Tendency (CT) subdimension, a statistically significant difference was identified (F = 4.41, p < .001). Post-hoc comparisons showed that students with mathematics achievement scores between 0–44 and 45–54 had significantly higher CT scores than students with scores between 85–100.

Predictive Effect of Mathematics-Focused Academic Risk-Taking on Metacognitive Awareness

The results of the simple linear regression analysis examining the predictive effect of Mathematics-Focused Academic Risk-Taking (MFARTS) on Metacognitive Awareness (MA) are presented in Table 19.

Table 19

Regression Analysis Results for the Effect of Mathematics-Focused Academic Risk-Taking (MFARTS) on Metacognitive Awareness(MA)

Predictor	β	*SE*	*F*	*p*
Constant	2.93*	0.12	227.34	< .001
MFARTS	0.28*	0.01		

Notes: Dependent variable: Metacognitive Awareness (MA). Model fit: $F(1, 977) = 227.34$, *p < .001, R^2 = .275.

As shown in Table 19, the regression model was statistically significant, $F(1, 977)$ = 227.34, p < .001. The findings indicated that Mathematics-Focused Academic Risk-Taking significantly predicted Metacognitive Awareness (β = .28, p < .001). When the explanatory power of the model was examined, the MFARTS variable explained approximately 27.5% of the variance in Metacognitive Awareness (R^2 = .275), indicating a moderate level of predictive power.

Furthermore, the positive regression coefficient indicates that as mathematics-focused academic risk-taking increases, metacognitive awareness also tends to increase, suggesting a direct and positive relationship between these variables. In practical terms, this finding implies that students who are more willing to take academic risks in mathematics are likely to exhibit higher levels of metacognitive awareness. Based on the regression analysis, the prediction equation obtained for Metacognitive Awareness was formulated as follows: MA = 2.93 + 0.28 × MFARTS. This equation indicates that for each one-unit increase in MFARTS, Metacognitive Awareness increases by 0.28 units, holding other factors constant.

Predictive Effect of Irrational Mathematics Beliefs on Metacognitive Awareness

The results of the simple linear regression analysis examining the predictive effect of Irrational Mathematics Beliefs (IMBS) on Metacognitive Awareness (MA) are presented in Table 20.

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Table 20

Regression Analysis Results for the Effect of Irrational Mathematics Beliefs (IMBS) on Metacognitive Awareness (MA)

Predictor	β	SE	*F*	*p*
Constant	2.91*	0.12	221.31	< .001
IMBS	-0.06*	0.06		

Notes: Dependent variable: Metacognitive Awareness (MA). Model fit: $F(1, 977) = 221.31$, $^*p < .001$; $R^2 = 0.264$.

As shown in Table 20, the regression model was statistically significant, $F(1, 977) = 221.31$, $p < .001$. The findings indicated that Irrational Mathematics Beliefs significantly predicted Metacognitive Awareness ($\beta = -.06$, $p < .001$). When the model's explanatory power was examined, IMBS accounted for approximately 26.4% of the variance in Metacognitive Awareness ($R^2 = .264$), indicating a moderate level of predictive power.

Furthermore, the negative regression coefficient indicates that as irrational mathematics beliefs increase, metacognitive awareness tends to decrease, suggesting an inverse relationship between these two constructs. In practical terms, this finding implies that students who hold stronger irrational beliefs about mathematics are likely to demonstrate lower levels of metacognitive awareness. Based on the regression analysis, the prediction equation obtained for Metacognitive Awareness was formulated as follows: $MA = 2.91 - 0.06 \times IMBS$. This equation indicates that for each one-unit increase in IMBS, Metacognitive Awareness decreases by 0.06 units, holding other factors constant.

Discussion

This study examined cognitive–affective predictors of metacognitive awareness in mathematics learning among lower-secondary students. Overall, students demonstrated moderate-to-high metacognitive awareness, moderate mathematics-focused academic risk-taking, and moderate irrational mathematics beliefs, with meaningful differentiation by grade level and mathematics achievement. These findings support contemporary views that metacognition functions as a self-regulatory system shaped not only by cognitive resources but also by affective beliefs and engagement tendencies in learning contexts (Efklides, 2008; Efklides & Metallidou, 2020; Erdoğan & Aydın, 2024; Kohen & Kramarski, 2018; Schraw & Moshman, 1995; Winne & Azevedo, 2014; Zimmerman, 2002).

Metacognitive Awareness Level and Group Differences

Students' metacognitive awareness levels were moderate to high, consistent with theoretical accounts suggesting that metacognitive knowledge and regulation develop across schooling but can be constrained by increasing academic demands and evaluative pressure (Flavell, 1979, 1987; Pintrich, 2002; Veenman, 2015; Veenman & van Cleef, 2019). The finding that 5th graders reported higher metacognitive awareness than upper grades may reflect a transition effect in which early lower-secondary students remain more open to reflective monitoring and strategy use, whereas older students may adopt more performance-driven and routine strategies as assessment stakes rise (Veenman, 2015; Zohar & Barzilai, 2013). Additionally, higher mathematics achievement was associated with higher metacognitive awareness, aligning with evidence that metacognitive monitoring and regulation relate to mathematical performance across ages and learning tasks (Muncer et al., 2022; Özsoy, 2011; Xie et al., 2024). In contrast, no significant gender differences emerged for metacognitive

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awareness, which is consistent with studies showing that metacognitive competence is not inherently gendered and is often more sensitive to instructional experiences and classroom norms than to demographic categories (Lingel et al., 2019; Veenman, 2015).

Academic Risk-Taking as a Positive Predictor

Regression results showed that mathematics-focused academic risk-taking positively predicted metacognitive awareness, indicating that students who are more willing to engage with challenge and persist after errors tend to report stronger monitoring and regulation of their thinking. This pattern is theoretically coherent: risk-taking in learning contexts encourages students to test strategies, receive feedback from failure, and reflect on the effectiveness of their approaches processes central to metacognitive regulation (Brown, 1980, 1987; Clifford, 1988; Clifford & Chou, 1991). It also aligns with perspectives in mathematics education that emphasize that productive struggle, uncertainty, and strategy revision are critical conditions under which metacognition becomes visible and functional (Zohar & David, 2008; Zohar & Barzilai, 2013). From a pedagogical standpoint, this supports the argument that classrooms that normalize error and encourage intellectual risk are likely to foster both strategic flexibility and self-regulated learning (Beghetto, 2021; Beghetto & Glăveanu, 2022; Sharma, 2015). The moderate overall level of risk-taking observed in the sample further suggests that many students may still approach mathematics with caution highlighting the practical importance of building psychologically safe learning climates and feedback practices that treat mistakes as informational rather than threatening (Beghetto et al., 2021; Kramarski, 2008; Kramarski et al., 2021).

Irrational Beliefs as a Negative Predictor

The study also found that irrational mathematics beliefs negatively predicted metacognitive awareness, consistent with REBT-informed accounts that rigid, absolutist beliefs about failure and self-worth can interfere with adaptive learning behavior and cognitive regulation (Ellis, 1995; Ellis et al., 2010; Dryden, 2010, 2013, 2024; Dryden & Ellis, 2001). When students interpret mistakes as unacceptable or as evidence of incapacity, attention may shift away from task-focused monitoring toward self-protective avoidance, thereby weakening reflective evaluation and strategic control (Gómez-Chacón et al., 2024; Pennequin et al., 2020). This interpretation also aligns with research linking maladaptive beliefs to mathematics anxiety and impaired metacognitive insight in decision-making contexts (Desender & Sasanguie, 2022; Morsanyi et al., 2019). In the present results, irrational beliefs tended to vary by grade level and achievement, which is consistent with the view that belief systems are shaped by accumulated school experiences, perceived competence, and exposure to evaluative norms in mathematics classrooms (Desoete & De Craene, 2019; Li & Yuan, 2022; Li et al., 2022).

Implications For Mathematics Instruction and Student Support

The findings reinforce a cognition–affect integration perspective: metacognitive awareness in mathematics is strengthened by students' engagement behaviors (risk-taking) and weakened by maladaptive belief structures (Efklides, 2008; Efklides & Metallidou, 2020). Practically, interventions can target both pathways. First, instructional designs that explicitly teach planning, monitoring, evaluation routines and encourage reflective dialogue can strengthen metacognitive regulation and strategic transfer (Armbruster & Brown, 1984; Hartman, 2001; Pintrich, 2002; Winne & Azevedo, 2014). Second, "error-friendly" pedagogies and structured opportunities for revision may increase productive academic risk-taking by reframing uncertainty as a normal

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component of mathematical inquiry (Beghetto, 2021; Zohar & Barzilai, 2013). Third, belief-focused supports such as cognitive reframing consistent with REBT principles may help reduce irrational beliefs that undermine persistence and self-regulation, especially when linked to test anxiety and threat appraisals (Dryden & Ellis, 2001; Zhou et al., 2022).

Limitations and Future Research

Because the study used a cross-sectional, correlational design, results should be interpreted as predictive associations rather than causal effects (Creswell & Creswell, 2017; Karasar, 2022). In addition, measures were self-report, which captures perceived tendencies rather than real-time regulatory behavior; future work could incorporate performance-based or process measures (e.g., think-alouds, observational coding, or online monitoring indicators) to strengthen validity (Veenman & van Cleef, 2019; Winne & Azevedo, 2014). Finally, the convenience sample limits generalizability; replication across different school contexts and instructional climates would clarify how classroom norms and feedback practices shape the risk–belief–metacognition nexus (Fraenkel et al., 2012).

Conclusions and Implications

This study explored the cognitive–affective predictors of metacognitive awareness in mathematics learning among lower-secondary school students. The findings indicate that mathematics-focused academic risk-taking is a significant positive predictor of metacognitive awareness, whereas irrational mathematics beliefs function as a significant negative predictor. Together, these results highlight that students' engagement with challenge and their belief systems are meaningfully associated with how they monitor and regulate their thinking in mathematics.

The findings reinforce a cognition–affect integration perspective, suggesting that metacognitive awareness does not develop solely from cognitive maturation but is closely intertwined with students' behavioral engagement and evaluative interpretations of failure. Students who are willing to take intellectual risks appear more likely to engage in planning, monitoring, and strategy revision processes, whereas rigid and absolutist beliefs about mathematics may shift attention away from reflective regulation toward self-protective avoidance. These results extend existing metacognitive frameworks by empirically demonstrating that both adaptive engagement tendencies and maladaptive belief structures are associated with metacognitive functioning in mathematics contexts.

From an educational perspective, the findings suggest that supporting metacognitive development requires attention to classroom climate and belief systems in addition to explicit strategy instruction. Error-friendly pedagogical practices, opportunities for productive struggle, and reflective dialogue may foster academic risk-taking and strengthen regulatory awareness. At the same time, instructional approaches that challenge irrational beliefs about ability, failure, and control may help prevent affective barriers that undermine self-regulated learning.

Importantly, the cross-sectional and correlational design does not permit causal conclusions. The observed relationships should therefore be interpreted as predictive associations rather than directional effects. Future longitudinal and experimental research is needed to determine whether increasing academic risk-taking or reducing irrational beliefs causally enhances metacognitive awareness and mathematics achievement, or whether reciprocal dynamics better explain these relationships.

Overall, this study contributes to mathematics education research by demonstrating that metacognitive awareness is shaped not only by cognitive processes but also by students' willingness to engage with uncertainty and their interpretations of error and ability. Supporting

students' development in mathematics therefore requires a balanced focus on cognitive strategy instruction and adaptive affective dispositions.

Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and relevant national regulations. Ethical approval for the study was obtained from the Social and Humanities Ethics Committee Committee], [Çanakkale Onsekiz Mart University] (Approval No: [E-84026528-050.01.04-2200301370-22/44], Date: [16.12.2022]). In addition, permission to conduct the research in the participating schools was granted by the [İstanbul Province] Provincial Directorate of National Education, which is the competent authority responsible for all public schools in the province (Official Permission No: [E-59090411-44-68585836], Date: [17.01.2023]).

Consent for publication

This manuscript does not contain any individual person's data in any form (including images, videos, or other identifying personal details).

Availability of data

The datasets are available from the corresponding author upon reasonable request.

Authors' contributions

All authors contributed to the conception and design of the study. Material preparation, data collection, and statistical analyses were performed by [FTT] and [DG]. [FTT], as a master's student, conducted the research and drafted the initial version of the manuscript. [DG] supervised the study, contributed to data interpretation, and critically revised the manuscript for important intellectual content. Both authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Competing interests

The authors declare that they have no competing interests.

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PROBLEMS
OF EDUCATION
IN THE 21st
CENTURY

GUIDE FOR AUTHORS

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The publication language is English. All authors must take care of the language revision on their own. The language must be clear and accurate. The work should be written in an impersonal style. The editor reserves the right to send the manuscript to be reviewed. If English is a second language for the author, please consider having the manuscript proof read and edited before submitting.

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The main research idea/problem should be reflected in the title. The title should show the nature of the research/study. It is recommended to avoid the title of the question form. The recommended length for a title is no more than 12 words (APA, 2.01, p. 23).
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Author names and affiliations

Full names/surnames should be provided. Please indicate affiliations of the author(s). All the e-mails should be indicated below.

Abstract

The first page of the manuscript must begin with the title of the paper and an abstract which should be about 150 - 250 words. For the papers reporting original research, state in brief: the primary/main aim (the research questions addressed or any hypothesis tested); the research design; the methods and procedures employed; the number of participants; the main outcomes and results; the conclusions drawn from these data and results, including their implications for further research or application/practice. An abstract represents briefly a content of a text. Do not cite references in the abstract. The abstract should grip the reader's attention.

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Please provide 3 to 5 keywords in alphabetical order. Note that a keyword does not have to be made of only one word. At least one of these should indicate the topic area and one should indicate the methodology of the research.

The structure of the manuscript (recommended)

The body of the text of the manuscript must generally have the following parts:
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- discussion;
- conclusions and/or implications;
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- references (in APA style, 7th Ed);
- appendix (if any).

P.S. The structure can be different if the paper is only theoretical qualitative research.

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The manuscript should be not shorter than 6 pages (including references, tables and figures). Manuscripts should be typed on A4, in Times New Roman 12-point font size, single-spaced, 2.5 cm with all the margins, word-document (Word 6.0 or later) format.

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Tables and figures should be valuable, relevant, and visually attractive. Tables (made in Word or another software) and figures must be referred to in the text and numbered in the order of their appearance. Each table and figure should have a complete, descriptive title; and each table column an appropriate heading. The texts in tables and figures should be 11-point (in some cases 10) and their width should be 12 cm at maximum. The figures should be in format .jpg (unless done in Word or Excel); resolution 1200 dpi. Figures, tables (black and white colour, without ground-colour) and captions should be inserted within the manuscript at their appropriate locations. All the graphics (figures) must be editable. The font size should be Times New Roman for all figures and tables. Figures should be carefully explained in the text and cited in numerical order.
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The author should make sure that there is a strict one-to-one correspondence between the names and years in the text and those on the list. All the references should be listed in alphabeti¬cal order by author's name.
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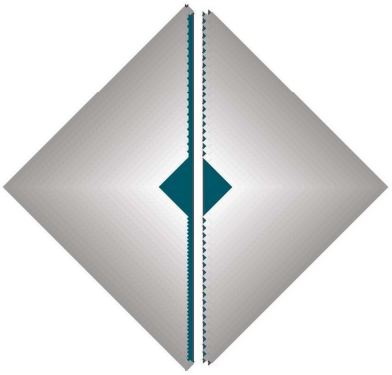

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